PC 2-8-18
#3
4 Pages

Planning Department <planning@edcgov.us>

Conditional Use Permit S17-0016AT&T CAF4

1 message

Bruce <brucecrawford77@att.net> Thu, Jan 18, 2018 at 12:55 PM
To: planning@edcgov.us, james.williams@edcgov.us
Cc: Bruce <brucecrawford77@att.net>, marjicrawford@att.net

James Williams, Planning Commissioner, District 4

County of El Dorado Planning Commission

2850 Fairlane Court

Placerville, CA 95667

Email: james.williams@edcgov.us

Reference: Conditional Use Permit S17-0016/AT&T CAF4 (see attachment)

Dear James Williams,

I am writing regarding my concerns for the construction and operation of the wireless telecommunication facility consisting of a new monopine tower and ground equipment at Site 6-Zee Estates - Assessor's parcel Number 104-370-24.

This proposed cell tower is planned to be built 50 feet off our western property line. We oppose the construction of this cell tower at this specific location: On the west side of Gate Lane, approximately 925 feet southeast of the intersection with Salmon Falls Rd. El Dorado County Assessor's parcel Number 104-370-24.

In May 2017 we moved to the property located at 860 Gate Lane, Pilot Hill, CA. We chose this property largely because of the 360 degree unobstructed views of the natural skyline, the mountains surrounding Tahoe, Folsom Lake and the extremely quiet noise level (ambient noise is currently very low approximately 30dB). Currently, this low noise level allows us to hear the silence and occasional wildlife.

We moved from the congested, noisy, and viewless Bay Area to a beautiful, peaceful place and we want it to stay that way.

The following is a listing of some of our biggest concerns with this cell tower:

Obstructed View

The tower as planned is 160 feet tall and only 500 feet away from our house. This cell tower will dominate by 100 feet over the surrounding trees that are about 60 feet high at max. Even though the tower will be disguised as a "tree" this camouflage does not even come close to looking like the surrounding vegetation. It will stick out like a sore thumb. This tower is going to be in "direct line of sight" from my home. We will see it when approaching our home, from our driveway, and every time we enter or exit though our front door or garage.

Noise

From my research, this cell tower will ADD at least 50dB. I have found several instances on the internet of existing cell towers making substantial noise and disturbing the nearby residents. This tower is going to be 500 feet away and in "direct line of sound" to our home. There will be nothing muting the noises emitted from the tower. The constant drone from the electronic equipment will be very intrusive. This will cause me and my family stress which equates to poorer health.

There will be considerable construction noise although this is only a transient noise, lasting perhaps only a couple of months; this will be a daily stressor for those months in our lives.

Maintenance of the tower will be frequent and will create noise, again adding stress to our lives.

In addition there will be a back-up diesel generator that will run frequently creating additional noise.

EMF and RF

If this cell tower is constructed, there will be more EMF and RF energy in and around our house. I am not going to debate whether this additional energy is harmful or not, **nevertheless the additional EMF and RF energy emitted from the cell tower is a concern to me and my family.**

Many websites point out that cell towers do in fact cause many health concerns in humans from the EMF and RF energy emitted.

Effect on the Power Grid

Also there are new studies looking at the EMF health concern associated with these cell towers because of the effect on the power grid.

An excerpt from

https://www.sott.net/article/294466-The-growing-cell-tower-menace-to-our-health:

"Some highly regarded researchers and scientists have suggested another EMF health concern associated with these cell towers - high frequency harmonic noise induced on the local power grid. Massive amounts of AC power must be converted to DC power for all the transmitters/receivers that make up the cell base station (tower). This conversion process creates harmonic noise at high frequencies and this noise couples to the local grid and appears in the power grid of homes in the local vicinity of the cell tower. This high frequency noise can couple to the human body via electric/magnetic fields induced by the home power grid (wiring, sockets, appliances, etc)."

Inadequate Setback

The tower is 160 feet tall. It is proposed to be 50 feet from our property line. It should be at least 160 feet from our property line a 1/1 setback. This would prevent it from damaging our trees and plants, and possible future structures if it fell.

Reduction in property value

From my research, I have found that this tower will very likely decrease the value of my property. It sure will not increase it. This is based on many comparable real estate parcels in California. "Anything that makes your neighborhood or house less attractive upon resale whether true, scientific or just preference should be considered." Even if the evidence is not conclusive that cell tower radiation in small amounts is harmful, the economic impact is the same to us if a buyers avoids our house because of this or any other concerns that I have listed in this letter.

Fire Hazard

There are several instances of cell towers catching fire and burning. This proposed location is in a California fire hazard severity zone 10, which is the highest severity fire hazard zone. This unmanned facility is an additional fire risk in this extreme fire area.

The property owner of the proposed site has no home on this 60 acre property. He/she does not have to live with the obstructed view or the noise of this tower, and yet the tower is put right next to my home and my neighbor's home, and the property owners will be getting monthly lease income, without any of the downside.

We ask that a new location be found for this cell tower.

Bruce A. Crawford

Marjorie A. Crawford

860 Gate Lane

Pilot Hill, CA 95664-9250

Email: brucecrawford77@att.net

Cell: 408.718.2582

Conditional Use Permit S17-0016AT&T CAF4.pdf
864K

COMMUNITY DEVELOPMENT SERVICES
PLANNING AND BUILDING DEPARTMENT
http://www.edcgov.us/DevServices/

PLACERVILLE OFFICE:
2850 Fairlane Court, Placerville, CA 95667
BUILDING
(530) 621-5315 / (530) 622-1708 Fax
bldgdept@edcgov.us
PLANNING
(530) 621-5355 / (530) 642-0508 Fax
planning@edcgov.us

LAKE TAHOE OFFICE:
924 B Emerald Bay Rd
South Lake Tahoe, CA 96150
(530) 573-3330
(530) 542-9082 Fax

NOTICE OF PUBLIC HEARING

The **County of El Dorado Planning Commission** will hold a public hearing in the Building C Hearing Room, 2850 Fairlane Court, Placerville, CA 95667 on **February 8, 2018, at 8:30 a.m.**, to consider: **Conditional Use Permit S17-0016/AT&T CAF4** submitted by AT&T MOBILITY (Agent: Epic Wireless) to allow the construction and operation of seven separate wireless telecommunication facilities consisting of seven new monopine towers ranging in size from 120 to 160 feet, with individual ground equipment with fencing. The properties are as follows: **Site 1-Cool:** Assessor's Parcel Number 071-032-15, consisting of 25 acres, is located on the south side of Triple Seven Road, approximately 1,200 feet south of the intersection with Highway 193, in the Cool area, Supervisorial District 4; **Site 2-Newtown:** Assessor's Parcel Number 077-091-06, consisting of 4.9 acres, is located on the east side of Snows Road, approximately 365 feet east of the intersection with Clouds Rest Road, in the Newtown area, Supervisorial District 3; **Site 3-Pleasant Valley:** Assessor's Parcel Number 078-180-38, consisting of 2 acres, is located on the north side of Pleasant Valley Road, approximately 400 feet west of the intersection with Mount Aukum Road, in the Pleasant Valley Rural Center, Supervisorial District 2; **Site 4-Soapweed:** Assessor's Parcel Number 085-010-13, consisting of 10 acres, is located on the north side of Stope Road, approximately 1,200 feet north of the intersection with Dickinson Road, in the Swansboro area, Supervisorial District 4; **Site 5-Latrobe:** Assessor's Parcel Number 087-181-10, consisting of 20 acres, is located on the west side of Dragon Point Road, approximately 0.3 miles southwest of the intersection with Latrobe Road, in the Latrobe area, Supervisorial District 2; **Site 6-Zee Estates:** Assessor's Parcel Number 104-370-24, consisting of 60 acres, is located on the west side of Gate Lane, approximately 925 feet southeast of the intersection with Salmon Falls Road, in the Pilot Hill area, Supervisorial District 4; and **Site 7-Gold Hill:** Assessor's Parcel Number 105-110-81, consisting of 10 acres, is located on the south side of Gods Way, approximately 2,200 feet south of the intersection with Clark Mountain Road, in the Lotus area, Supervisorial District 4. (County Planner: Evan Mattes) (Mitigated Negative Declaration prepared)*

Staff Reports are available two weeks prior at https://eldorado.legistar.com/Calendar.aspx

All persons interested are invited to attend and be heard or to write their comments to the Planning Commission. If you challenge the application in court, you may be limited to raising only those items you or someone else raised at the public hearing described in this notice, or in written correspondence delivered to the Commission at, or prior to, the public hearing. Any written correspondence should be directed to the County of El Dorado Planning and Building Department, 2850 Fairlane Court, Placerville, CA 95667 or via e-mail: planning@edcgov.us.

*This is a notice of intent to adopt the negative declaration or mitigated negative declaration that has been prepared for this project and which may be reviewed and/or obtained in the County of El Dorado Planning and Building Department, 2850 Fairlane Court, Placerville, CA 95667, during normal business hours or online at http://edcapps.edcgov.us/Planning/ProjectInquiry.asp. A negative declaration or mitigated negative declaration is a document filed to satisfy CEQA (California Environmental Quality Act). This document states that there are no significant environmental effects resulting from the project, or that conditions have been proposed which would mitigate or reduce potential negative effects to an insignificant level. The public review period for the negative declaration or mitigated negative declaration set forth in CEQA for this project is thirty days, beginning January 6, 2018, and ending February 4, 2018 (or next business day).

To ensure delivery to the Commission prior to the hearing, written information from the public is encouraged to be submitted by Thursday the week prior to the meeting. Planning Services cannot guarantee that any FAX or mail received the day of the Commission meeting will be delivered to the Commission prior to any action.

COUNTY OF EL DORADO PLANNING COMMISSION
ROGER TROUT, Executive Secretary
January 5, 2018

PC 2-8-18
#3
3 Pages

Planning Department <planning@edcgov.us>

FW: Conditional Use Permit S17-0016AT&T CAF4

1 message

Bruce <brucecrawford77@att.net> Thu, Jan 18, 2018 at 1:48 PM
To: atttowers@att.com, releaseadmin@att.com
Cc: marjicrawford@att.net, Bruce <brucecrawford77@att.net>, planning@edcgov.us, james.williams@edcgov.us

Dear Sirs or Madams;

Please see the forwarded email pertaining to the cell tower proposed to be built 50 feet from my property. My wife and I oppose the installation on this site, and request that the tower be relocated for the reasons specified in the forwarded email.

We are serious about opposing this tower, and hope that you will be able to secure another location, however we are prepared to take legal action if necessary.

Bruce A. Crawford

Marjorie A. Crawford

860 Gate Lane

Pilot Hill, CA 95664-9250

Email: brucecrawford77@att.net

Cell: 408.718.2582

From: Bruce [mailto:brucecrawford77@att.net]
Sent: Thursday, January 18, 2018 12:56 PM
To: 'planning@edcgov.us'; 'james.williams@edcgov.us'
Cc: Bruce (brucecrawford77@att.net); marjicrawford@att.net
Subject: Conditional Use Permit S17-0016AT&T CAF4

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18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

with Salmon Falls Rd. El Dorado County Assessor's parcel Number 104-370-24.

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Email: brucecrawford77@att.net

Cell: 408.718.2582

Conditional Use Permit S17-0016AT&T CAF4.pdf
864K

PC 2-8-18
#3
3 Pages

Planning Department <planning@edcgov.us>

Notice of Public Hearing for proposed Cell Phone Tower in Pleasant Valley

1 message

Scott Schilling <scottschilling@att.net> Thu, Jan 18, 2018 at 2:45 PM
Reply-To: Scott Schilling <scottschilling@att.net>
To: "bostwo@edcgov.us" <bostwo@edcgov.us>, "planning@edcgov.us" <planning@edcgov.us>
Cc: "edc.cob@edcgov.us" <edc.cob@edcgov.us>

Hello Shiva and Planning Dept.

Our community received the attached notice from the Community Development Services Planning and Building Dept. regarding a notice of public hearing for a proposed cell phone tower right next door to our property. I would not have realized it is being planned next door until I did a parcel search. APN 078-180-38.

My wife and I moved to this property in 1989 from the Sacramento region to get away from typical industrial and city development seeking a rural lifestyle in a natural setting. We raised 3 great kids here which now have their own homes and families. We love Pleasant Valley and the furthest thing from our mind when we moved here would be a proposed cell phone tower, towering next door like a sore thumb.

Yes, they say it will look like a tree. Well... I have seen them and no, it would not blend in with the surrounding landscape. That is only one of our worries as well as with other neighbors that will be living under the umbrella of immense microwave radiation which is also a major concern. Yes, there have been many studies I have researched arguing both ways. I know it wasn't that long ago that we were warned to not hold cell phones to our head but use Bluetooth or tethered headsets. We now have grandchildren visiting often and we don't want to take the chance of health risks associated.

Another major concern we have is that a cell phone tower is a commercial business in a residential R2A zone. They would be accessing our unmaintained road and property by an easement for construction and maintenance not to mention strangers and additional traffic in our immediate community ongoing.

The residential owner of the proposed tower location would be compensated $1300.00 per month which I believe would classify it as a commercial business as well.

In closing, I am not objecting to technology as I recognize the need to replace transmission lines with cell technology. I am only objecting to the location. There are plenty of hilltops surrounding the Pleasant Valley area where it would make much more sense out of view and mitigate any potential health risk byu locating this tower out of our residential neighborhood.

Shiva, Please help by attending and representing us in this hearing on February 8th @ 8:30am

Thank you,

Best regards,

Scott and Rhonda Schilling
4601 Pleasant Valley Ct.
Placerville, CA
530 644 8771

Cell Phone Tower0001.pdf
1253K

COMMUNITY DEVELOPMENT SERVICES

PLANNING AND BUILDING DEPARTMENT

http://www.edcgov.us/DevServices/

PLACERVILLE OFFICE:
2850 Fairlane Court, Placerville, CA 95667
BUILDING
(530) 621-5315 / (530) 622-1708 Fax
bldgdept@edcgov.us
PLANNING
(530) 621-5355 / (530) 642-0508 Fax
planning@edcgov.us

LAKE TAHOE OFFICE:
924 B Emerald Bay Rd
South Lake Tahoe, CA 96150
(530) 573-3330
(530) 542-9082 Fax

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COUNTY OF EL DORADO PLANNING COMMISSION
ROGER TROUT, Executive Secretary
January 5, 2018

PC 2-8-18
#3
2 Pages

Planning Department <planning@edcgov.us>

Conditional Use Permit S17-0016/AT&T CAF4

1 message

Michel Bloch <michelbloch520@gmail.com> Wed, Jan 24, 2018 at 12:01 AM
To: planning@edcgov.us

1/23/2018

County of El Dorado
Planning and Building Department
2850 Fairlane Court
Placerville, CA 95667

RE: Conditional Use Permit Site 1-Cool

To Whom This Concerns:

I am one of two El Dorado County residents with property on Triple Seven Road in the Cool area, Supervisorial District 4. I challenge AT&T Mobility's application for a Conditional Use Permit for a new monopine tower on Site 1-Cool. Site 1 is located on Accessor's Parcel Number 071-032-15.

Initially, the idea seems impractical. There is an existing Verizon/Nextel monopine, or cell phone tower approximately one quarter of a mile from this cell phone tower's proposed location. Close by, or approximately one mile from this Verizon cell phone tower is another monopine tower near the intersection of Highway 49 and Catecroft Way. This area in square miles must already have suitable cell phone reception with these two towers to satisfy the public domain.

I was curious about the zoning on Triple Seven Road for the proposed cell phone tower. On January 18, 2018, I spoke with the Planning Commissions director for Site 1. I wanted to determine if my local government offered substantial evidence to justify their zoning decision for this cell phone tower, per the Federal Telecommunications Act. The Commission's director for Site 1 offered no evidence to support the installation of this proposed third cell phone tower. Additionally, the U.S. government's standard for the cell phone tower is based upon legislation passed in the 1990s. This legislation indicates that the preferred installation for cell phone towers be in commercial and industrial areas, not residential areas. Site 1 on Triple Seven Road is in a residential area of El Dorado County.

My doubts about the necessity for this Site 1 cell phone tower installation increased when AT&T informed me that my AT&T internet connection, which is currently consistently fast and constant, could be upgraded if I chose to purchase the Site 1 cell phone tower's broadband. I do not need the proposed cell phone tower's broadband, as I doubt my rural neighbors with internet connections will need this broadband connection.

The argument in favor of this cell phone tower would appear to be weak considering the above stated facts. I am hopeful that I will receive, reasonable and thoroughly researched arguments to counter the above experiences.

If El Dorado County's Planning Commission accepts AT&T Mobility's application for the Site 1-Cool Conditional Use Permit despite my challenge against this installation, I would like the Commission to consider my other challenge against the installation, based upon the private road with a single lane bridge that AT&T proposes to use to install and maintain their installation. Triple Seven Road and the bridge on the road were created to provide the sole ingress and egress for the two residences on Triple Seven Road: 3060 and 3100 Triple Seven Road. The single lane wooden bridge crosses an irrigation ditch on Triple Seven Road. With the Conditional Use Permit, AT&T will drive many truckloads of concrete, lumber, fencing materials, metal fabrications, and sections of the tower over the bridge and on Triple Seven Road. All crossing this small wooden bridge. Then after the tower is installed, AT&T will continue to drive over the bridge and use Triple Seven Road. The wooden bridge will gradually sink under the weight of the AT&T vehicles into the irrigation ditch. With a sinking bridge, a period of normal rainfall will insure that the bridge will be flooded, or covered by irrigation ditch water, prohibiting the egress and the ingress for individuals living on Triple Seven Road. I want an independent civil engineer to access this bridge's ability to maintain the weight of AT&T's loads and vehicles.

The repair of this wooden bridge and Triple Seven Road will be at the expense of myself and my neighbor. With AT&T traffic and loads, the bridge will deteriorate rapidly, in contrast to it's deterioration when used solely by the individuals from the two residences on Triple Seven Road.

Concurrently, AT&T will continue to encroach, driving on the private road crossing my property. I am against AT&T Mobility's application for a Conditional Use Permit on Site 1 based primarily upon this expected damage to the wooden bridge, and the encroachment on my property, using the Triple Seven Road easement.

I have sought legal counsel for this last challenge against AT&T Mobility's Site 1. I appreciate this opportunity to express my challenge against this proposed cell phone tower installation. Thank you.

Sincerely yours,

Ann Gualtieri
Property Owner on Triple Seven Road

PC 2-8-18
#3
Pages 313

Public Comment received – Hand delivered 01/25/18

Received by Randy Hellesing

INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS

DIVISION OF OCCUPATIONAL HEALTH, SAFETY AND MEDICINE

Position on the Health Effects from Radio Frequency/Microwave (RF/MW) Radiation in Fire Department Facilities fron Base Stations for Antennas and Towers for the Conduction of Cell Phone Transmissions

The International Association of Fire Fighters' position on locating cell towers commercial wireless infrastructure o fire department facilities, as adopted by its membership in August 2004 (1), is that the IAFF oppose the use of fir stations as base stations for towers and/or antennas for the conduction of cell phone transmissions until a study wit the highest scientific merit and integrity on health effects of exposure to low-intensity RF/MW radiation is conducte and it is proven that such sitings are not hazardous to the health of our members.

Further, the IAFF is investigating funding for a U.S. and Canadian study that would characterize exposures from RF/M\ radiation in fire houses with and without cellular antennae, and examine the health status of the fire fighters as a function c their assignment in exposed or unexposed fire houses. Specifically, there is concern for the effects of radio frequency radiatio on the central nervous system (CNS) and the immune system, as well as other metabolic effects observed in preliminar studies.

It is the belief of some international governments and regulatory bodies and of the wireless telecommunications industry that n consistent increases in health risk exist from exposure to RF/MW radiation unless the intensity of the radiation is sufficient to he body tissue. However, it is important to note that these positions are based on non-continuous exposures to the general public t low intensity RF/MW radiation emitted from wireless telecommunications base stations. Furthermore, most studies that are th basis of this position are at least five years old and generally look at the safety of the phone itself. IAFF members are concerne about the effects of living directly under these antenna base stations for a considerable stationary period of time and on a dail basis. There are established biological effects from exposure to low-level RF/MW radiation. Such biological effects ar recognized as markers of adverse health effects when they arise from exposure to toxic chemicals for example. The IAFF's effort will attempt to establish whether there is a correlation between such biological effects and a health risk to fire fighters an emergency medical personnel due to the siting of cell phone antennas and base stations at fire stations and facilities where the work.

Background

Critical questions concerning the health effects and safety of RF/MW radiation remain. Accordingly, should we allow exposure c our fire fighters and emergency medical personnel to this radiation to continue for the next twenty years when there is ongoin controversy over many aspects of RF/MW health effects? While no one disagrees that serious health hazards occur when livin cells in the body are heated, as happens with high intensity RF/MW exposure (just like in a microwave oven), scientists ar currently investigating the health hazards of low intensity RF/MW exposure. Low intensity RF/MW exposure is exposure whic does not raise the temperature of the living cells in the body.

Additionally, a National Institute of Environmental Health Sciences panel designated power frequency electromagnetic field (ELF/EMF) as "possible human carcinogens." (2) In March 2002 The International Association on Research on Cancer of th World Health Organization also assigned this designation to ELF/EMF in Volume 80 of its *IARC Monographs on the Evaluation c Carcinogenic Risks to Humans.* (3)

Fixed antennas used for wireless telecommunications are referred to as cellular base stations, cell stations, PCS ("Person Communications Service") stations or telephone transmission towers. These base stations consist of antennas and electroni equipment. Because the antennas need to be high in the air, they are often located on towers, poles, water tanks, or rooftop Typical heights for freestanding base station towers are 50-200 feet.

Some base stations use antennas that look like poles, 10 to 15 feet in length, that are referred to as "omni-directiona antennas. These types of antennas are usually found in rural areas. In urban and suburban areas, wireless providers no more commonly use panel or sector antennas for their base stations. These antennas consist of rectangular panels, about 1 b 4 feet in dimension. The antennas are usually arranged in three groups of three antennas each. One antenna in each group i used to transmit signals to wireless phones, and the other two antennas in each group are used to receive signals fror wireless phones.

At any base station site, the amount of RF/MW radiation produced depends on the number of radio channels (transmitters) pe antenna and the power of each transmitter. Typically, 21 channels per antenna sector are available. For a typical cell sit using sector antennas, each of the three transmitting antennas could be connected to up to 21 transmitters for a total of 6 transmitters. When omni-directional antennas are used, a cellular base station could theoretically use up to 96 transmitter Base stations used for PCS communications generally require fewer transmitters than those used for cellular radi transmissions, since PCS carriers usually have a higher density of base station antenna sites.

The electromagnetic RF/MW radiation transmitted from base station antennas travel toward the horizon in relatively narro paths. The individual pattern for a single array of sector antennas is wedge-shaped, like a piece of pie. Cellular and PCS bas stations in the United States are required to comply with limits for exposure recommended by expert organizations an endorsed by government agencies responsible for health and safety. When cellular and PCS antennas are mounted o rooftops, RF/MW radiation levels on that roof or on others near by would be greater than those typically encountered on th ground.

The telecommunications industry claims cellular antennas are safe because the RF/MW radiation they produce is too weak t cause heating, i.e., a "thermal effect." They point to "safety standards" from groups such as ANSI/IEEE or ICNIRP to suppo their claims. But these groups have explicitly stated that their claims of "safe RF/MW radiation exposure is harmless" rest o the fact that it is too weak to produce a rise in body temperature, a "thermal effect."-(4)

There is a large body of internationally accepted scientific evidence which points to the existence of non-thermal effects c RF/MW radiation. The issue at the present time is not whether such evidence exists, but rather what weight to give it.

Internationally acknowledged experts in the field of RF/MW radiation research have shown that RF/MW transmissions of th type used in digital cellular antennas and phones can have critical effects on cell cultures, animals, and people in laboratorie and have also found epidemiological evidence (studies of communities, not in the laboratory) of serious health effects at "nor thermal levels," where the intensity of the RF/MW radiation was too low to cause heating. They have found:

- Increased cell growth of brain cancer cells (5)
- A doubling of the rate of lymphoma in mice (6)
- Changes in tumor growth in rats (7)
- An increased number of tumors in rats (8)
- Increased single- and double-strand breaks in DNA, our genetic material (9)
- 2 to 4 times as many cancers in Polish soldiers exposed to RF (10)
- More childhood leukemia in children exposed to RF (11)
- Changes in sleep patterns and REM type sleep (12)
- Headaches caused by RF/MW radiation exposure (13)
- Neurologic changes (14) including:
    - Changes in the blood-brain-barrier (15)
    - Changes in cellular morphology (including cell death) (16)

  - Changes in neural electrophysiology (EEG) [17]
  - Changes in neurotransmitters (which affect motivation and pain perception) [18]
  - Metabolic changes (of calcium ions, for instance) [19]
  - Cytogenetic effects (which can affect cancer, Alzheimer's, neurodegenerative diseases) [20]

- Decreased memory, attention, and slower reaction time in school children [21]
- Retarded learning in rats indicating a deficit in spatial "working memory" [22]
-

EMF Safety Network

We envision a world free of EMF pollution where children, communities, and nature thrive! Our mission is to educate and empower people by providing science and solutions to reduce EMFs to improve lives, achieve public policy change, and obtain environmental justice.

EMF and RF World Concerns Summary

Facebook Twitter

The following is a compilation of what government, public health and environment organizations and officials, independent scientists, health advocacy groups and activists are advocating around the world in response to the proliferation of electromagnetic fields, and especially 2.4 GHZ microwave radiation.

International Resolutions Advocating a Precautionary Approach to the Use and Expansion of Wireless Technologies:

Vienna resolution 1998
http://www.icems.eu/docs/resolutions/Vienna_Resolution_1998.pdf

Salzburg Austria Resolution 2000:http://www.salzburg.gv.at/salzburg_resolution_e.pdf

Catania Italy 2002 http://www.emrpolicy.org/faq/catania.pdf

Benevento Italy Resolution 2006 http://www.icems.eu/benevento_resolution.htm

London Resolution 2007: http://www.icems.eu/docs/resolutions/London_res.pdf

Venice Italy Resolution 2008 http://www.icems.eu/resolution.htm

Porto Alegre Resolution 2009:
http://www.icems.eu/docs/resolutions/Porto_Alegre_Resolution.pdf

Wingspread Conference on the Precautionary principle: http://www.sehn.org/wing.html

Wi-Fi

European Environmental Agency advises the precautionary principle for wi-fi: http://www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed

http://www.independent.co.uk/environment/green-living/eu-watchdog-calls-for-urgent-action-on-wifi-radiation-402539.html

German Government advises against wi-fi: http://www.independent.co.uk/environment/green-living/germany-warns-citizens-to-avoid-using-wifi-401845.html

http://www.icems.eu/docs/deutscher_bundestag.pdf

France National Library and several other Paris libraries are wi-fi-free http://www.next-up.org/pdf/FranceNationalLibraryGivesUpWiFi07042008.pdf

http://lavieverte.wordpress.com/2008/05/23/public-libraries-in-paris-shut-down-wifi-in-response-to-health-worries/

(USA) Progressive Librarians Guild recommends the precautionary principle for wireless exposures in libraries. June 2008. http://progressivelibrariansguild.org/content/wifiresolution.shtml

UK: The Association of Teachers and Lecturers (ATL) with 160,000 members has called for a government investigation into the biological and thermal effects of “wi-fi” networks

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Wednesday, November 1, 2017

Electromagnetic Hypersensitivity

What is electromagnetic hypersensitivity?

Following is an excerpt from "Electromagnetic hypersensitivity means Peter Lloyd can't leave his house... or enjoy any modern pleasures inside" by Martin Shipton, *Wales Online*, Oct 16, 2014:

The term "electrical hypersensitivity" was first used in 1989, while "electromagnetic hypersensitivity" - EHS for short - was coined in 1994 to reflect sufferers' sensitivity to magnetic as well as electric fields.

As early as the 1930s, however, EHS symptoms were observed in people working with radio and electricity, and with military radar in the 1940s.

Environmental EHS appeared in the general population from the 1970s with computers.

It increased in the 1980s with mobile and cordless phones, and with wifi from 2000.

Thousands of people are now linked with EHS support groups in 30 countries. The first started in Sweden in 1989; the UK group began in 2003.

Sweden recognised EHS as a functional disability in 2002. The Canadian Human Rights Commission did likewise in 2007.

In 2009, the European Parliament voted for persons with EHS to be recognised as disabled.

Despite having official recognition, many doctors still know little or nothing about the condition.

http://bit.ly/211JeT7

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Vital Signs with Dr. Sanjay Gupta

Dr. Sanjay Gupta, CNN's Chief Medical Correspondent, has produced a program on **Electromagnetic Hypersensitivity** which is currently being shown on CNN International. CNN will air the program in the U.S. on October 21 and November 4.

You can watch the program online now by viewing the following three videos on the CNN website:

Part 1 (9-minute video): **Welcome to the National Quiet Zone** - with Diane Schou and Dr. David Carpenter. In a small West Virginia town, a restriction on wireless internet and phone signals provides a refuge to disconnect.
http://cnn.it/2floP7A

Part 2 (7-minute video): **Reducing Wireless Exposure** - with Dr. Joel Moskowitz, Melissa Chalmers, Kevin Mottus, and Dafna Tachover. As the world becomes more connected, how can you reduce your exposure to electromagnetic fields?
http://cnn.it/2yBjBgB

Part 3 (5-minute video): **Living in the National Quiet Zone** - with Leo Halepli. What life is like for a young man from Turkey now living in the small town of Green Bank, West Virginia.
http://cnn.it/2wgekcD

Note: Dr. Gupta's statement that non-ionizing radiation cannot cause DNA damage is false. The National Toxicology Program found that mice and rats exposed to non-ionizing, cell phone radiation developed DNA damage. Numerous studies have found evidence of DNA damage from exposure to low-intensity radiofrequency radiation (RFR). At least seven published studies have found evidence of DNA damage in humans. The DNA damage may be an indirect effect of the oxidative stress caused by exposure to RFR.

Discussion Questions:

Joel M. Moskowitz, Ph.D.
Director
Center for Family and Community He
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety

Archive

Why doesn't our Federal government conduct or fund research on Electromagnetic Hypersensitivity and other health effects (e.g., cancer, reproductive and neurological damage) associated with exposure to radiofrequency radiation? The only major study the government has conducted in the past two decades. the National Toxicology Program study on second-generation (2G) cell phone radiation, was requested by the FDA in 1999 and still has not been completed.

Why doesn't the Federal Communications Commission update its decades-old guidelines for radiofrequency radiation exposure based upon the latest international research that finds biologic and health effects from current levels of exposure to radiofrequency radiation?

Related Post:

How does wireless radiation produce harmful health effects?

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Mobile Phone Use and The Risk of Headache:
A Systematic Review and Meta-analysis of Cross-sectional Studies

Wang J, Su H1, Xie W, Yu S. Mobile Phone Use and The Risk of Headache: A Systematic Review and Meta-analysis of Cross-sectional Studies. Sci Rep. 2017 Oct 3;7(1):12595. doi: 10.1038/s41598-017-12802-9.

Abstract

Headache is increasingly being reported as a detrimental effect of mobile phone (MP) use. However, studies aimed to investigate the association between MP use and headache yielded conflicting results. To assess the consistency of the data on the topic, we performed a systematic review and meta-analysis of the available cross-sectional studies. Published literature from PubMed and other databases were retrieved and screened, and 7 cross-sectional studies were finally included in this meta-analysis. The pooled odds ratio (OR) and 95% confidence interval (CI) were calculated. We found that the risk of headache was increased by 38% in MP user compared with non-MP user (OR, 1.38; 95% CI, 1.18-1.61, $p < 0.001$). Among MP users, the risk of headache was also increased in those who had longer daily call duration (2-15 min vs. <2 min: OR, 1.62; 95% CI, 1.34-1.98, $p < 0.001$; >15 min vs. <2 min: OR, 2.50; 95% CI, 1.76-3.54, $p < 0.001$) and higher daily call frequency (2-4 calls vs. <2 calls: OR, 1.37; 95% CI, 1.07-1.76, $p < 0.001$; >4 calls vs. <2 calls: OR, 2.52; 95% CI, 1.78-3.58, $p < 0.001$). Our data indicate that MP use is significantly associated with headache, further epidemiologic and experimental studies are required to affirm and understand this association.

Excerpts

The underlying mechanism of the association between MP use and headache remains unclear but some suggest that breakdown of the blood-brain barrier due to exposure to low intensity MP frequency microwave energy may be involved 33,34,35,36. Also, the dopamine-opiate system may be involved in headaches and low intensity electromagnetic energy exposure affects those systems 37,38,39. However, since Frey's group first reported headaches occurring after microwave energy exposure at approximately the same frequencies and incident energies that present day MP emit40, the exact mechanism under this association is still not fully understood now.

The results of our meta-analysis and lots of previous studies herein supported current clinical opinion that MP use may cause increased risk for headache. Therefore, it is advisable to admit that the use of MP is a risk factor for headache. In Stalin's study 18 and Chiu's study 19, the prevalence of MP usage among adult and children was 69.8% and 63.2% respectively in their study population, and that was only the data from two years ago. We could foresee the prevalence of MP usage will be higher in the future. So it is also advisable to suggest that excessive use of MP should be avoided by increasing social awareness through health promotion activities. It is imperative that health care professionals, clinicians and common people are educated about the deleterious influence of MP on headache. And it is reasonable to instruct children and adolescent about a prudent use of MPs. In addition, we encourage screening of headache patients during routine clinical visits to identify those patients to explore excessive MP use as a potential cause. Intervention and policies must be developed, evaluated and carry out at the population level to raise the awareness of the potential adverse health effect to decrease the headache caused by MP using.

Open Access Paper: https://www.nature.com/articles/s41598-017-12802-9

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Special Issue on Ecopsychology and Environmental Sensitivities:
Chemical, Electrical, and Beyond

Ecopsychology, Vol. 9, Issue 2

http://online.liebertpub.com/toc/eco/9/2

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EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment
of EMF-related health problems and illnesses

Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, Kundi M, Moshammer H, Lercher P, Müller K, Oberfeld G, Ohnsorge P, Pelzmann P, Scheingraber C, Thill R. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses.Rev Environ Health. Publ online 2016 Jul 25. doi: 10.1515/reveh-2016-0011.

Abstract

Chronic diseases and illnesses associated with unspecific symptoms are on the rise. In addition to chronic stress in social and work environments, physical and chemical exposures at home, at work, and during leisure activities are causal or contributing environmental stressors that deserve attention by the general practitioner as well as by all other members of the health care community. It seems certainly necessary now to take "new exposures" like electromagnetic field (EMF) into account. Physicians are increasingly confronted with health problems from unidentified causes.

Studies, empirical observations, and patient reports clearly indicate interactions between EMF exposure and health problems. Individual susceptibility and environmental factors are frequently neglected. New wireless technologies and applications have been introduced without any certainty about their health effects, raising new challenges for medicine and society. For instance, the issue of so-called non-thermal effects and potential long-term effects of low-dose exposure were scarcely investigated prior to the introduction of these technologies. Common EMF sources include Wi-Fi access points, routers and clients, cordless and mobile phones including their base stations, Bluetooth devices, ELF magnetic fields from net currents, ELF electric fields from electric lamps and wiring close to the bed and office desk. On the one hand, there is strong evidence that long-term-exposure to certain EMF exposures is a risk factor for diseases such as certain cancers, Alzheimer's disease and male infertility. On the other hand, the emerging electromagnetic hypersensitivity (EHS) is more and more recognized by health authorities, disability administrators and case workers, politicians, as well as courts of law.

We recommend treating EHS clinically as part of the group of chronic multisystem illnesses (CMI) leading to a functional impairment (EHS), but still recognizing that the underlying cause remains the environment. In the beginning, EHS symptoms often occur only occasionally, but over time they may increase in frequency and severity. Common EHS symptoms include headaches, concentration difficulties, sleeping problems, depression, lack of energy, fatigue and flu-like symptoms.

A comprehensive medical history, which should include all symptoms and their occurrences in spatial and temporal terms and in the context of EMF exposures, is the key to the diagnosis. The EMF exposure can be assessed by asking for typical sources like Wi-Fi access points, routers and clients, cordless and mobile phones and measurements at home and at work. It is very important to take the individual susceptibility into account.

The primary method of treatment should mainly focus on the prevention or reduction of EMF exposure, that is, reducing or eliminating all sources of EMF at home and in the workplace. The reduction of EMF exposure should also be extended to public spaces such as schools, hospitals, public transport, and libraries to enable persons with EHS an unhindered use (accessibility measure). If a detrimental EMF exposure is reduced sufficiently, the body has a chance to recover and EHS symptoms will be reduced or even disappear. Many examples have shown that such measures can prove effective. Also the survival rate of children with leukemia depends on ELF magnetic field exposure at home.

To increase the effectiveness of the treatment, the broad range of other environmental factors that contribute to the total body burden should also be addressed. Anything that supports a balanced homeostasis will increase a person's resilience against disease and thus against the adverse effects of EMF exposure. There is increasing evidence that EMF exposure has a major impact on the oxidative and nitrosative regulation capacity in affected individuals. This concept also may explain why the level of susceptibility to EMF can change and why the number of symptoms reported in the context of EMF exposures is so large. Based on our current understanding, a treatment approach that minimizes the adverse effects of peroxynitrite - as has been increasingly used in the treatment of multisystem disorders - works best.

This EMF Guideline gives an overview of the current knowledge regarding EMF-related health risks and provides concepts for the diagnosis and treatment and accessibility measures of EHS to improve and restore individual health outcomes as well as for the development of strategies for prevention.

http://bit.ly/2asNTuj

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Electrohypersensitivity: a functional impairment due to an inaccessible environment

Johansson O. Electrohypersensitivity: a functional impairment due to an inaccessible environment. Rev Environ Health. 2015 Dec 1;30(4):311-21. doi: 10.1515/reveh-2015-0018.

Abstract

In Sweden, electrohypersensitivity is recognized as a functional impairment which implies only the environment as the culprit. The Swedish view provides persons with this impairment a maximal legal protection, it gives them the right to get accessibility measures for free, as well as governmental subsidies and municipality economic support, and to provide them with special Ombudsmen (at the municipality, the EU, and the UN level, respectively), the right and economic means to form disability organizations and allow these to be part of national and international counterparts, all with the simple and single aim to allow persons with the functional impairment electrohypersensitivity to live an equal life in a society based on equality. They are not seen as patients, they do not have an overriding medical diagnosis, but the 'patient' is only the inferior and potentially toxic environment.

This does not mean that a subjective symptom of a functionally impaired can not be treated by a physician, as well as get sick-leave from their workplace as well as economic compensation, and already in the year 2000 such symptoms were identified in the Internal Code of Diagnoses, version 10 (ICD-10; R68.8/now W90), and have been since. But the underlying cause still remains only the environment.
http://1.usa.gov/1YFwzkd

Excerpts

The very first case may have been Nikola Tesla (10 July 1856–7 January 1943) a Serbian-American inventor, electrical engineer, mechanical engineer, physicist, and futurist, best known for his contributions to the design of the modern alternating current (AC) electricity supply system. Descriptions of his health status closely resembles what we today would have named electro-hypersensitivity. A surge of similar case reports were also seen during the amateur radio (DX) years.

In more recent times, as early as in the 1970s, a report from the former Soviet Union described a "microwave syndrome". The Soviet military recognized early on the possible side-effects from radar and radio radiation. This microwave syndrome was seen in up to a quarter of the military personnel working with radio and radar equipment. They showed symptoms such as fatigue, dizziness, headaches, problems with concentration and memory, sleep disturbances, and being hot tempered. The treatment suggested was a change of assignments and to keep away from exposure. Rest, physical exercise, and nutritious food were also offered (8).

Also in the 1970s the newspaper industry was one of the first to supply it's employees with personal computers using visual display terminals. Complaints of headaches and visual problems, as well as clusters of miscarriages and birth defects in children born to female editors and other newspaper employees, generated some publicity. In addition, many people who worked in the electronics industry in Sweden, including an estimated 12% of the electrical engineers in that industry, became electrically sensitive, and helped form the current Swedish disability organization ...

In the United States, then-Representative Al Gore held Congressional hearings in 1981 on the health effects of computer screens ....

Today the most famous electrohypersensitive person is Gro Harlem Brundtland (20 April 1939), the former Prime Minister of Norway and the former Director General of the UN World Health Organization (WHO).

I and my collaborator, Dr. Shabnam Gangi, in two papers of theoretical nature (27, 28), have put forward a model for how mast cells and substances secreted from them (e.g. histamine, heparin, and serotonin) could explain sensitivity to electromagnetic fields...

When it comes to functional impairments, it is always only action that speaks, nothing else. To ensure that everyone acts within the UN Human Rights Convention is of paramount importance, and that persons with EHS is promptly given complete accessibility is the only acceptable goal, as is proper symptom identification and treatment when possible, but only when asked for by the disabled person Himself/Herself. However, the latter should never be used instead of the first.

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Biomarkers for diagnosing electrohypersensitivity & multiple chemical sensitivity: Two etiopathogenic aspects of a unique pathological disorder

Belpomme D, Campagnac C, Irigaray P. Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. Rev Environ Health. 2015 Dec 1;30(4):251-71. doi: 10.1515/reveh-2015-0027.

Abstract

Much of the controversy over the causes of electro-hypersensitivity (EHS) and multiple chemical sensitivity (MCS) lies in the absence of both recognized clinical criteria and objective biomarkers for widely accepted diagnosis.

Since 2009, we have prospectively investigated, clinically and biologically, 1216 consecutive EHS and/or MCS-self reporting cases, in an attempt to answer both questions. We report here our preliminary data, based on 727 evaluable of 839 enrolled cases: 521 (71.6%) were diagnosed with EHS, 52 (7.2%) with MCS, and 154 (21.2%) with both EHS and MCS. Two out of three patients with EHS and/or MCS were female; mean age (years) was 47. As inflammation appears to be a key process resulting from electromagnetic field (EMF) and/or chemical effects on tissues, and histamine release is potentially a major mediator of inflammation, we systematically measured histamine in the blood of patients. Near 40% had a increase in histaminemia (especially when both conditions were present), indicating a chronic inflammatory response can be detected in these patients. Oxidative stress is part of inflammation and is a key contributor to damage and response. Nitrotyrosin, a marker of both peroxynitrite (ONOO°-) production and opening of the blood-brain barrier (BBB), was increased in 28% the cases. Protein S100B, another marker of BBB opening was increased in 15%. Circulating autoantibodies against O-myelin were detected in 23%, indicating EHS and MCS may be associated with autoimmune response. Confirming animal experiments showing the increase of Hsp27 and/or Hsp70 chaperone proteins under the influence of EMF, we found increased Hsp27 and/or Hsp70 in 33% of the patients. As most patients reported chronic insomnia and fatigue, we determined the 24 h urine 6-hydroxymelatonin sulfate (6-OHMS)/creatinin ratio and found it was

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

decreased (<0.8) in all investigated cases. Finally, considering the self-reported symptoms of EHS and MCS, we serially measured the brain blood flow (BBF) in the temporal lobes of each case with pulsed cerebral ultrasound computed tomosphygmography. Both disorders were associated with hypoperfusion in the capsulothalamic area, suggesting that the inflammatory process involve the limbic system and the thalamus.

Our data strongly suggest that EHS and MCS can be objectively characterized and routinely diagnosed by commercially available simple tests. Both disorders appear to involve inflammation-related hyper-histaminemia, oxidative stress, autoimmune response, capsulothalamic hypoperfusion and BBB opening, and a deficit in melatonin metabolic availability; suggesting a risk of chronic neurodegenerative disease. Finally the common co-occurrence of EHS and MCS strongly suggests a common pathological mechanism.

http://1.usa.gov/1NEtsXW

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The microwave syndrome or electro-hypersensitivity: historical background

Carpenter DO. The microwave syndrome or electro-hypersensitivity: historical background. Rev Environ Health. 2015 Nov 10. doi: 10.1515/reveh-2015-0016. [Epub ahead of print]

Abstract

Microwave generating equipment first became common during World War 2 with the development of radar. Soviet bloc countries reported that individuals exposed to microwaves frequently developed headaches, fatigue, loss of appetite, sleepiness, difficulty in concentration, poor memory, emotional instability, and labile cardiovascular function, and established stringent exposure standards. For a variety of reasons these reports were discounted in Western countries, where the prevailing belief was that there could be no adverse health effects of electromagnetic fields (EMFs) that were not mediated by tissue heating. The reported Soviet effects were at lower intensities than those that cause heating. However, there were several accidental exposures of radar operators in Western countries that resulted in persistent symptoms similar to those described above. The Soviets irradiated the US Embassy in Moscow with microwaves during the period 1953-1975, and while no convincing evidence of elevated cancer rates was reported, there were reports of "microwave illness." Officials passed these complaints off as being due to anxiety, not effects of the microwave exposure. There is increasing evidence that the "microwave syndrome" or "electro-hypersensitivity" (EHS) is a real disease that is caused by exposure to EMFs, especially those in the microwave range. The reported incidence of the syndrome is increasing along with increasing exposure to EMFs from electricity, WiFi, mobile phones and towers, smart meters and many other wireless devices. Why some individuals are more sensitive is unclear. While most individuals who report having EHS do not have a specific history of an acute exposure, excessive exposure to EMFs, even for a brief period of time, can induce the syndrome.

http://1.usa.gov/1HDPOWI

Excerpts

Electro-hypersensitivity (EHS) is a syndrome that may include some or all of the following: excessive fatigue, headache, tinnitus, insomnia, photophobia, a feeling of cognitive dysfunction and impaired memory, irritability, pain at various sites and often cardiovascular abnormalities (1). However, these are all relatively common complaints. All of us have on occasion suffered from headaches and insomnia. Because the symptoms are relatively non-specific, and because the adverse health effects of electromagnetic fields (EMFs) is a contentious issue, and also because primary care physicians have no objective diagnostic algorithms by which to diagnose EHS, patients suffering from EHS are often referred to a psychiatrist. There is, however, a body of evidence, both old and more recent, that indicates that these symptoms are triggered by exposure to EMFs in sensitive individuals. This is the case for exposure to both the extra low electromagnetic fields (ELF) coming from electricity and the radiofrequency (RF) EMFs coming from radar, communication devices, WiFi, smart meters and many other forms of wireless devices.

There are conflicting estimates on what percent of the population suffers from EHS, with some suggesting that between 5 and 10% of people have the syndrome, and that the incidence is increasing with time (2). However, there are several reports of tests of individuals taken into a laboratory and their responses recorded when they were unaware of whether or not an EMF field was being applied. Some of these studies have not shown that individuals who report that they are electro-sensitive are in fact able to discern if the EMFs are present or not (3–6). However, these reports are balanced by others that show that at least some individuals do respond with adverse symptoms when exposed to EMFs in a blinded fashion (7, 8). Thus not everyone who believes they are electrosensitive really is, but it is also likely that some have the symptoms of EHS but have not identified the cause. Thus the true incidence of EHS is currently not known.

... the Soviet countries' standard for maximal permissible [EMF] exposure during the workday is 1,000 times lower than that in the US. [0.01 mW/cm2 over an entire workday]

Some of the strongest evidence that EHS is a real syndrome comes from cases of acute high intensity exposure to microwaves of healthy people, which resulted in prolonged illness ....

Recent years have seen a marked increase in overall exposure to EMFs ....There has always been uncertainty over which characteristics of EMFs are most important with regard to human health effects. Because the mechanisms whereby these various adverse health outcomes arise are still not well understood, it is important to ask the question of which components pose the greatest risk, whether or not we are confident of the answer. Frey (36, 37) first suggested that peak power density was more important than average power density. Litovitz et al. (38) concluded that 60 Hz EMFs and RF EMFs do very much the same things, and later studies suggested that the low frequency, modulatory component of RF was particularly important (39). Others have implicated on-off transients, "dirty electricity" and other characteristics of the fields than the steady 50 or 60 Hz fields.

... smart meter RF radiation is significantly different from many other forms of RF, in that it consists of brief but very high intensity pulses. Thus, whereas the average exposure over time is not excessive it appears possible that the high intensity pulses are responsible for the development of EHS. Brief intense pulses have been described as "dirty electricity" by Milham and Morgan (33), who suggest that many of the reported adverse effects of EMFs are due to these brief events, rather than the sine wave forms ...

Conclusion

The weight of evidence indicates that EHS is a real syndrome induced by exposure to either ELF or RF EMF. In some cases it results from a brief, high intensity exposure, whereas in others it appears to reflect ambient exposures, especially those of increasing intensity and perhaps of certain waveforms. Whether from acute high intensity exposure or ambient background exposure from cell towers, mobile phones, smart meters and other devices, it is clear that not everyone develops EHS, for reasons not well understood. Certainly more research is needed to understand exactly which of the components of EMF exposures pose the greatest danger to human health, and what biological mechanisms are responsible. But the important conclusion is that there is something about EMFs of various forms that do pose direct hazards to human health.

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Electromagnetic Hypersensitivity (EHS):
Fad Allergy, Debilitating Disease, or What?

The National Law Review, Oct 15, 2015

"... electromagnetic hypersensitivity (or "EHS" – sensitivity to radio waves from Wi-Fi routers, cell phones and similar products) is an "allergy" that has recently gotten more mainstream media attention and is also "characterized by a range of non-specific symptoms." The Access Board, which is the federal agency responsible for promulgating accessibility guidelines under the Americans with Disabilities Act, has recognized that "electromagnetic sensitivities may be considered disabilities under the ADA ...."

<snip>

"The upshot of court rulings to date is that while some courts will overlook the lack of scientific evidence that EHS is caused by exposure to EMF in the context of government benefits, they have not been so accommodating where another individual's (or company's) rights would be adversely affected by a ruling in favor of an EHS plaintiff."

"If EHS becomes as prevalent as "gluten sensitivity," we can expect more EHS sufferers to ask courts to fashion them a remedy. Unlike bread and pasta for the gluten-obsessed, EMF is not something a person can easily avoid. Americans are exposed to EMF on a daily basis, from the likes of garage door openers, cell phones, cordless phones, laptops, tablets, to Wi-Fi routers in their homes, supermarkets, malls and places of work. Radio frequency energy is literally everywhere. While there is no science to support the causation hypothesis, people who believe they have EHS *really believe* they have a legitimate sensitivity, and many have demonstrable symptoms that are not frivolous. That makes for motivated litigants, which means the courts will probably see more of these cases in the future. But for courts to decide that EHS is something more than a fad allergy, or a psychological manifestation arising from the nocebo effect, they will need controlled scientific studies supporting the case—studies that at the moment do not exist."

Complete article: http://bit.ly/1VUUvg8

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2015 International Scientific Declaration on
Electromagnetic Hypersensitivity
and Multiple Chemical Sensitivity

ARTAC / ECERI Press Release, Sep 4, 2015

Following the **fifth Paris Appeal Congress,** which took place on the 18th of May, 2015 and focused on environmental hypersensitivities, the attending European, American and Canadian scientists unanimously decided to create a working group and to write a Common International Declaration to request an official recognition of these new diseases and of their sanitary consequences worldwide.

The declaration calls upon national and international bodies and institutions and particularly the World Health

Organization, **for taking urgently their responsibility for recognizing electrohypersensitivity and multiple chemical sensitivity as real diseases, including them in the International Classification of Diseases.**

This International Declaration also asks national and international institutions to adopt simple precautionary measures of prevention, to inform populations and **requires the appointment of real independent expert groups to evaluate these sanitary risks in total scientific objectivity,** which is not the case today.

For the Scientific Committee of the Paris Appeal Fifth Congress:

Pr. David Carpenter, MD (USA)
Pr. Lennart Hardell, MD, PhD (Sweden)
Pr. Dominique Belpomme, MD, MS (France

Brussels International Scientific Declaration : ***www.appel-de-paris.com***

To download the Declaration: http://bit.ly/ehsDeclaration
To download the Program of the Congress: http://bit.ly/ParisEHSappeal2

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Ex-WHO General-Director Warns:
"Wireless Technology has Health Effects There is no Doubt "

YouTube, Aug 20, 2015 (3:20)

On August 14, 2015, retired General-Director of the World Health Organization and former Prime Minister of Norway, Dr. Gro Harlem Brundtland, was interviewed by the Norwegian newspaper ***Aftenposten***.

One issue discussed in the interview was her current thoughts about wireless radiation. Her statement was crystal clear. Watch the relevant clip from the interview here, subtitled in English by Citizens´ Radiation Protection, Norway.

http://bit.ly/1hykTzF

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What does the World Health Organization say about EHS?

The EHS overview on the World Health Organization's web site is nine years old. When will the WHO inform the public about the world-wide program of EMF studies on EHS it is co-ordinating?

Electromagnetic fields and public health: Electromagnetic hypersensitivity

Backgrounder, World Health Organization, December 2005

<snip>

What WHO is doing

WHO, through its International EMF Project, is identifying research needs and co-ordinating a world-wide program of EMF studies to allow a better understanding of any health risk associated with EMF exposure. Particular emphasis is placed on possible health consequences of low-level EMF. Information about the EMF Project and EMF effects is provided in a series of fact sheets in several languages www.who.int/emf/.

http://www.who.int/peh-emf/publications/facts/fs296/en/

Resources

Hypersensitivity to WiFi ... Could it be a disability?

Alexis Kramer. Hypersensitivity to WiFi ... Could it be a disability? Bloomberg BNA. Sep 10, 2015. http://www.bna.com/hypersensitivity-wifi-disability-b17179935773/

On Sept. 1, a federal district court in Florida refused to dismiss an ADA claim based on allegations that an individual experienced insomnia, loud and violent ear ringing and difficulty concentrating as a result of the attachment of a digital meter to his home.

The court said that because these symptoms substantially limited major life activities and derived from "some sort of physical or mental impairment," it could reasonably infer that the plaintiff has a disability.

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Electromagnetic hypersensitivity --

an increasing challenge to the medical profession

Hedendahl L, Carlberg M, Hardell L. Electromagnetic hypersensitivity - an increasing challenge to the medical profession. Rev Environ Health. 2015;30(4):209-15.

Abstract

BACKGROUND: In 1970, a report from the former Soviet Union described the "microwave syndrome" among military personnel, working with radio and radar equipment, who showed symptoms that included fatigue, dizziness, headaches, problems with concentration and memory, and sleep disturbances. Similar symptoms were found in the 1980s among Swedes working in front of cathode ray tube monitors, with symptoms such as flushing, burning, and tingling of the skin, especially on the face, but also headaches, dizziness, tiredness, and photosensitivity. The same symptoms are reported in Finns, with electromagnetic hypersensitivity (EHS) being attributed to exposure to electromagnetic fields (EMF). Of special concern is involuntary exposure to radiofrequency (RF)-EMF from different sources. Most people are unaware of this type of exposure, which has no smell, color, or visibility. There is an increasing concern that wireless use of laptops and iPads in Swedish schools, where some have even abandoned textbooks, will exacerbate the exposure to EMF.

METHODS: We have surveyed the literature on different aspects of EHS and potential adverse health effects of RF-EMF. This is exemplified by case reports from two students and one teacher who developed symptoms of EHS in schools using Wi-Fi.

RESULTS: In population-based surveys, the prevalence of EHS has ranged from 1.5% in Sweden to 13.3% in Taiwan. Provocation studies on EMF have yielded different results, ranging from where people with EHS cannot discriminate between an active RF signal and placebo, to objectively observed changes following exposure in reactions of the pupil, changes in heart rhythm, damage to erythrocytes, and disturbed glucose metabolism in the brain. The two students and the teacher from the case reports showed similar symptoms, while in school environments, as those mentioned above.

DISCUSSION: Austria is the only country with a written suggestion to guidelines on the diagnosis and treatment of EMF-related health problems. Apart from this, EHS is not recognized as a specific diagnosis in the rest of the world, and no established treatment exists.

CONCLUSION: It seems necessary to give an International Classification of Diseases to EHS to get it accepted as EMF-related health problems. The increasing exposure to RF-EMF in schools is of great concern and needs better attention. Longer-term health effects are unknown. Parents, teachers, and school boards have the responsibility to protect children from unnecessary exposure.

From: The Fifth Congress of the Paris Appeal: Environmental idiopathic intolerance: what role for EMFs and multiple chemicals? 18 May 2015, Brussels, Belgium.

Conclusions

The prevalence of EHS seems to be increasing today, and many people get symptoms when exposed to ELF- and/or RF-EMF. With the ever more extensive use of wireless technologies, nobody can avoid being exposed. It is important to work toward getting objective diagnostic criteria for EHS, and have it recognized and officially accepted as hypersensitivity, an illness caused by exposure to EMF. Thus, it is necessary to give an International Classification of Diseases to EHS. If and when EHS is accepted as a diagnosis by society and the medical profession, measures can be taken especially in consideration for this group of people with EHS regarding healthcare, accommodation, school, and work.

Measurements of exposure to EMF should be performed in classrooms and in school yards during a typical school week. The results must be evaluated in relation to current knowledge of biological effects from EMF exposure. This should lead to a precautionary approach using wired solution of the internet connection, but also reduction of other sources of EMF exposure. This approach should be similar as for control of exposure to other toxic agents such as asbestos and radon emissions. It is time to consider ELF-EMF and RF-EMF as environmental pollutants that need to be controlled.

http://1.usa.gov/1LkXxZQ

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Implications of non-linear biological oscillations on human electrophysiology for EHS and MCS

Sage C. The implications of non-linear biological oscillations on human electrophysiology for electrohypersensitivity (EHS) and multiple chemical sensitivity (MCS). Rev Environ Health. 2015 Sep 12.

Abstract

The 'informational content' of Earth's electromagnetic signaling is like a set of operating instructions for human life. These environmental cues are dynamic and involve exquisitely low inputs (intensities) of critical frequencies with which all life on Earth evolved. Circadian and other temporal biological rhythms depend on these fluctuating

electromagnetic inputs to direct gene expression, cell communication and metabolism, neural development, brainwave activity, neural synchrony, a diversity of immune functions, sleep and wake cycles, behavior and cognition. Oscillation is also a universal phenomenon, and biological systems of the heart, brain and gut are dependent on the cooperative actions of cells that function according to principles of non-linear, coupled biological oscillations for their synchrony. They are dependent on exquisitely timed cues from the environment at vanishingly small levels. Altered 'informational content' of environmental cues can swamp natural electromagnetic cues and result in dysregulation of normal biological rhythms that direct growth, development, metabolism and repair mechanisms. Pulsed electromagnetic fields (PEMF) and radiofrequency radiation (RFR) can have the devastating biological effects of disrupting homeostasis and desynchronizing normal biological rhythms that maintain health. Non-linear, weak field biological oscillations govern body electrophysiology, organize cell and tissue functions and maintain organ systems. Artificial bioelectrical interference can give false information (disruptive signaling) sufficient to affect critical pacemaker cells (of the heart, gut and brain) and desynchronize functions of these important cells that orchestrate function and maintain health. Chronic physiological stress undermines homeostasis whether it is chemically induced or electromagnetically induced (or both exposures are simultaneous contributors). This can eventually break down adaptive biological responses critical to health maintenance; and resilience can be compromised. Electrohypersensitivity can be caused by successive assaults on human bioelectrochemical dynamics from exogenous electromagnetic fields (EMF) and RFR or a single acute exposure. Once sensitized, further exposures are widely reported to cause reactivity to lower and lower intensities of EMF/RFR, at which point thousand-fold lower levels can cause adverse health impacts to the electrosensitive person. Electrohypersensitivity (EHS) can be a precursor to, or linked with, multiple chemical sensitivity (MCS) based on reports of individuals who first develop one condition, then rapidly develop the other. Similarity of chemical biomarkers is seen in both conditions [histamines, markers of oxidative stress, auto-antibodies, heat shock protein (HSP), melatonin markers and leakage of the blood-brain barrier]. Low intensity pulsed microwave activation of voltage-gated calcium channels (VGCCs) is postulated as a mechanism of action for non-thermal health effects.

http://1.usa.gov/1QMHYKT

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Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study

Dieudonné M. Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study. Bioelectromagnetics. 2015 Sep 15. doi: 10.1002/bem.21937. [Epub ahead of print]

Abstract

Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) is a condition in which symptoms are attributed to electromagnetic field (EMF) exposure. As electro-hypersensitive (EHS) people have repeatedly been observed, during provocation trials, to report symptoms following perceived rather than actual exposure, the hypothesis has been put forward that IEI-EMF originates from psychological mechanisms, especially nocebo responses. This paper examines this hypothesis, using data from a qualitative study aimed at understanding how EHS people come to regard themselves as such.

Forty self-diagnosed EHS people were interviewed.

A typified model of their attribution process was then elaborated, inductively, from their narratives. This model is linear and composed of seven stages: (1) onset of symptoms; (2) failure to find a solution; (3) discovery of EHS; (4) gathering of information about EHS; (5) implicit appearance of conviction; (6) experimentation; (7) conscious acceptance of conviction.

Overall, symptoms appear before subjects start questioning effects of EMF on their health, which is not consistent with the hypothesis that IEI-EMF originates from nocebo responses to perceived EMF exposure. However, such responses might occur at the sixth stage of the process, potentially reinforcing the attribution. It remains possible that some cases of IEI-EMF originate from other psychological mechanisms.

http://1.usa.gov/1JefNOy

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Metabolic and Genetic Screening of Electromagnetic Hypersensitive Subjects as a Feasible Tool for Diagnostics and Intervention

De Luca et al 2014. Metabolic and Genetic Screening of Electromagnetic Hypersensitive Subjects as a Feasible Tool for Diagnostics and Intervention. Mediators of Inflammation. Volume 2014, Article ID 924184. Open Access http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4000647/pdf/MI2014-924184.pdf

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This West Virginia Town Has Gone Radio Silent:

and government health agencies. Only Sweden recognizes EHS as a functional impairment, equivalent to a

Greetings from the Quiet Zone

Steve Featherstone, Popular Science, Apr 13, 2015 16, 2015

Excerpts

"According to the World Health Organization (WHO), EHS is not a medical diagnosis, but rather a vague set of symptoms with no apparent physiological basis. Even so, the condition--whatever its cause--appears to be widespread. Olle Johansson, an associate professor of neuroscience at the Karolinska Institute in Sweden, says the number of people who claim to have EHS varies by country, from 8 percent of the population in Germany to 3.5 percent, or about 11 million people, in the U.S."

"There are few epidemic diseases this large," Johansson says. "Nowadays, wherever you live, whatever you do, you're whole-body exposed, 24/7.""
"As palpable as Jane's symptoms are to her--and as certain as she is that they're caused by EMR--scientific consensus disagrees. Almost universally, scientists hold that most EMR has no adverse health effects at the levels people typically encounter. And no study has ever definitively linked EHS symptoms to RF radiation, a type of electromagnetic radiation that originates from wireless devices, such as Wi-Fi routers, cellphones, base stations, or Bluetooth antennas. "Health agencies have repeatedly waded through the scientific literature," says Kenneth Foster, professor of bioengineering at the University of Pennsylvania, "and they don't see any clear evidence that there's a problem other than if you put a rat in a microwave oven, it's bad for the rat."
"The only recognized health risk from RF radiation is the heating of tissue (as in the rat in the microwave). In 1996, the Federal Communications Commission adopted a safety standard for RF-emitting devices based on thermal heating. That's why even though the standard is set far below levels recognized to cause harm, wireless companies still recommend not carrying your phone around in your pocket or sleeping with one too close to your head."

"According to Joel Moskowitz, the director of the Center for Family and Community Health at the University of California at Berkeley, the test for the thermal standard is outdated if not irrelevant. "It's not at all reflective of what the average user looks like today and not really of any user anywhere," he says. "It's not even the right measurement." Moskowitz believes that science hasn't caught up with the rapid proliferation of RF-emitting devices--from smartphones to smart meters--that have been spilling radiation into our homes, schools, and workplaces over the past two decades. Electrosensitives may be the proverbial canaries in the coal mine, he says. He cites a growing body of research that suggests RF exposure has many nonthermal biological effects, including damage to sperm cells and changes in brain chemistry.

"There are a lot of unanswered questions, obviously, but we clearly have evidence for precautionary health warnings," Moskowitz says."

"Without an official medical diagnosis, it's difficult for EHS sufferers to claim benefits from insurance companies and government health agencies. Only Sweden recognizes EHS as a functional impairment, equivalent to a disability. But activists are beginning to have an impact on attitudes toward EHS and EMR-related issues, such as the use of wireless networks in public schools. Some day they hope that the medical establishment will treat EHS like other mysterious syndromes, such as fibromyalgia. They won a moral victory in 2011, when the WHO classified RF radiation as "possibly carcinogenic" in response to its Interphone study, which found a 40 percent greater risk for certain brain tumors at the highest exposure levels. (Scientists, however, did not find an increased incidence in cellphone users overall.) Then, in February of this year, France restricted the use of RF devices in daycare centers, citing a precautionary approach to exposure. Those gains aside, few if any studies are taking seriously the issue of EHS, and the inexorable expansion of wireless technologies does not appear to be slowing. Barring a breakdown in relations between electrosensitives and townsfolk or defunding of the GBT, Green Bank will continue to attract technological refugees searching for a safe haven from the electrosmog they feel is smothering the rest of the world."
"That's why I call [EHS] technological leprosy," Diane {Schou } said. "We can't be with other people in society. We have to live like lepers. Technology is wonderful stuff--if we aren't harmed by it."

This article was originally published in the April 2015 issue of* Popular Science, *under the title "Greetings From The Quiet Zone."

To read the entire article: http://bit.ly/1LjN9ml

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Is a toxicology model appropriate as a guide for biological research with electromagnetic fields?

My comments

The American neuroscientist, Allan H. Frey, published the first scientific paper that documented the microwave hearing effect in 1962. He published the first paper that documented leakage in the blood-brain barrier from exposure to microwave radiation in 1975. In the following letter from 1990, he discussed why the toxicology model is inappropriate for biologic research on electromagnetic fields.

Twenty-five years later, we have yet to fully comprehend this important message.

International guidelines and national regulatory standards assume a dose-response relationship exists between the power of an EMF exposure and the likelihood of a harmful health effect. However, biologic studies are finding harmful effects from sub-thermal exposures to microwave radiation at power levels that are a fraction of the regulatory limits.

Allan H. Frey. Letter to Editor: Is a toxicology model appropriate as a guide for biological research with electromagnetic fields? Journal of Bioelectricity. 9(2):233-234. 1990.

"... most people use a toxicology model as their frame of reference in the selection, funding, design and analysis of experiments. Data and theory show, however, that this is the wrong model (2-4). Thus much of the research has been inappropriate or irrelevant. This is one reason why hundreds of millions of dollars have been spent on EMF biological research with so little return for investment."

" ... living beings are electrochemical systems that use very low frequency EMFs in everything from protein folding through cellular communication to nervous system function."

" ... if we impose a very weak EMF signal on a living being, it has the possibility of interfering with normal function if it is properly tuned. This is the model that much biological data and theory tell us to use, not a toxicology model."

The letter can be viewed at: http://bit.ly/AFrey1990

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Is There a Connection Between Electrosensitivity and Electrosensibility?
A Replication Study

My comments

The electromagnetically sensitive (ES) participants selected for the following study were based upon individuals' responses to a self-reported measure. Most ES participants did not experience severe symptoms so it may be inappropriate to consider them to have electromagnetic hypersensitivity (EHS).

Like other sham provocation studies, this study assumed that someone with ES knows when they are exposed to an electromagnetic field (EMF) and when they are not. The study protocol assumed that there is no lag between the exposure and the ability to detect the exposure (or the non-exposure).

The study also assumed that **all** ES participants would be affected by exposure to a 50 Hz magnetic field. However, it is likely that some people who experience ES may be sensitive to certain radio frequency fields, but not ELF magnetic fields.

Despite the questionable assumptions upon which this study was based, the ES participants were significantly ($p = .038$) more likely to detect an MF exposure than chance would dictate. This result replicated the finding of an earlier study.

Szemerszky R, Gubányi M, Árvai D, Dömötör Z, Köteles F. Is There a Connection Between Electrosensitivity and Electrosensibility? A Replication Study. Int J Behav Med. 2015 Mar 17. [Epub ahead of print]

Abstract

BACKGROUND: Among people with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF), a better than random detection ability for a 50-Hz 0.5-mT magnetic field (MF) and a propensity to experience more symptoms than controls was reported in a previous study.

PURPOSE: The current study aimed to replicate and clarify these results using a modified experimental design.

METHOD: Participants of the provocation experiment were 49 individuals with self-reported IEI-EMF and 57 controls. They completed the questionnaires (symptom expectations, Somatosensory Amplification Scale-SSAS, radiation subscale of the Modern Health Worries Scale-MHWS Radiation) and attempted to detect the presence of the MF directed to their right arm in 20 subsequent 1-min sessions. Symptom reports were registered after each session.

RESULTS: Individuals with IEI-EMF as opposed to the control group showed a higher than random detection performance (d' index of signal detection theory), while no difference in their bias (β index) toward the presence of the MF was found. Predictors of reported symptoms were self-reported IEI-EMF and believed as opposed to actual presence of the MF. People with IEI-EMF reported significantly more symptoms particularly in the believed presence of the MF. IEI-EMF was closely related to MHWS Radiation and SSAS scores.

CONCLUSION: People with IEI-EMF might be able to detect the presence of the MF to a small extent; however, their symptom reports are connected to perceived exposure.

http://1.usa.gov/1LuKmHd

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Electromagnetic hypersensitivity:
EESC urges continuance of the precautionary principle
through regulation and advisory work (Ref: 06/2015)

Press Release, European Economic and Social Committee (EESC), Jan 23, 2015

At its January plenary session, the EESC adopted an opinion on electromagnetic hypersensitivity syndrome (EHS) which recognises the distress being suffered by people in Europe who believe they are affected. The opinion, which was adopted by 136 votes to 110 with 19 abstentions, calls for sympathetic and appropriate treatment and support for this condition.

Although the EESC opinion says that radiofrequency exposure is not causally linked to EHS symptoms, it urges continuance of the precautionary principle through regulation and advisory work, particularly as further research is still needed to accumulate evidence concerning any potential health impact from long-term exposure.

The EESC opinion on electromagnetic hypersensitivity syndrome points out that further substantial research is ongoing to understand the problem and its causes. It also notes that the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) has performed an extensive analysis of this issue and will shortly be completing its latest opinion which draws on a broad public consultation. The opinion will soon be adopted and will be published on the SCENIHR website (http://ec.europa.eu/health/scientific_committees/emerging/index_en.htm).

http://bit.ly/1BAvqz9

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Public Hearing on Electromagnetic Hypersensitivity

Between 3 and 5 per cent of the population are electrosensitive according to the European Economic and Social Committee.

Electromagnetic hypersensitivity (EHS) is causing distress and loss of quality of life to a growing number of Europeans and according to new estimates, between 3 % and 5% of the population are electro-sensitive. The most common sources of Electromagnetic Radiation (EMR) pollution are mobile phone masts, cordless phones and Wi-Fi routers installed in the homes. All these emit microwaves permanently (24/7) in the places where they are installed.

The European Economic and Social Committee (EESC) study group on electromagnetic hypersensitivity (EHS) will hold a public Hearing on EHS on Tuesday, November 4, 2014 in Brussels, Belgium.

This event will gather all relevant stakeholders from a broad range of European civil society for a debate on how to deal with this issues at EU level and to give input for the future EESC's opinion that is scheduled for adoption in January 2015.

The EESC is a consultative body of the European Union that gives representatives of Europe's socio-occupational interest groups and others, a formal platform to express their points of views on EU issues.

http://bit.ly/1tFQcLd

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EESC opinion: Exposure of workers to the risks arising from physical agents (electromagnetic fields)
European Economic and Social Committee, Dec 7, 2011

Proposal for a directive of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

Key points

- The EESC recommends that this directive be adopted and implemented in the legislation of Member States as soon as possible.
- However, the Committee is in favour of a precautionary approach being adopted without delay, given the risks of the non-thermal biological effects of emissions from electromagnetic fields. The long-term health of workers must be completely guaranteed at a high level through the introduction of the best available technologies at economically acceptable costs. The Committee expects a relevant provision to be incorporated into the directive.
- The EESC supports the Commission's initiative to fix thresholds so as to make this precautionary approach effective and credible; however, to ensure that this is absolutely effective it advocates fixed thresholds based on the thresholds applied when Directive 2004/40/EC was transposed (by Austria, the Czech Republic, Slovakia, Lithuania, Latvia, Estonia and Italy).
- The Committee stresses the need to strengthen the independence of scientific bodies involved in determining thresholds for workers' exposure to electromagnetic radiation, its effects and its consequences for public health, and in establishing measures to protect the health of workers exposed to this radiation. It is essential to put a stop

to conflicts of interest among members of these bodies, linked to the financing of their research and their appointment (procedures and calls for tender, use of independent public research institutes).

- The Committee concedes the need for a derogation for professions using magnetic resonance imaging (MRI) for medical purposes, which should however be subject to a time limit and accompanied by additional resources for research into new technologies to protect workers from the effects of electromagnetic fields and alternative techniques. Workers subject to the derogation should be covered by enhanced measures to protect them, special medical supervision and civil liability insurance to cover errors in the execution of their work arising from strong exposure to electromagnetic fields. The Committee also feels that the above-mentioned principles should be applied not only to medical workers, but also to all other workers who may be excluded from the general principles of the directive on the basis of the derogation included in Article 3 of the proposal.

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Electromagnetic hypersensitivity: EESC urges continuance of the precautionary principle through regulation and advisory work (Ref: 06/2015)

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http://bit.ly/1tFQcLd

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- The EESC supports the Commission's initiative to fix thresholds so as to make this precautionary approach effective and credible; however, to ensure that this is absolutely effective it advocates fixed thresholds based on the thresholds applied when Directive 2004/40/EC was transposed (by Austria, the Czech Republic, Slovakia, Lithuania, Latvia, Estonia and Italy).
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18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

and in establishing measures to protect the health of workers exposed to this radiation. It is essential to put a stop to conflicts of interest among members of these bodies, linked to the financing of their research and their appointment (procedures and calls for tender, use of independent public research institutes).

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Study of self-reported hypersensitivity to electromagnetic fields in California

Levallois P, Neutra R, Lee G, Hristova L. Study of self-reported hypersensitivity to electromagnetic fields in California. Environ Health Perspect. 2002 Aug;110 Suppl 4:619-23.

Abstract

Cases of alleged hypersensitivity to electromagnetic fields (EMFs) have been reported for more than 20 years, and some authors have suggested some connection with the "multiple chemical sensitivity" illness. We report the results of a telephone survey among a sample of 2,072 Californians. **Being "allergic or very sensitive" to being near electrical devices was reported by 68 subjects, resulting in an adjusted prevalence of 3.2%** (95% confidence interval = 2.8, 3.7). Twenty-seven subjects (1.3%) reported sensitivity to electrical devices but no sensitivity to chemicals. Characteristics of the people reporting hypersensitivity to EMFs were generally different from those of people reporting being allergic to everyday chemicals. Alleging environmental illness or multiple chemical sensitivity diagnosed by a doctor was the strongest predictor of reporting being hypersensitive to EMFs in this population. Other predictive factors apart from self-reporting chemical sensitivity were race/ethnicity other than White, Black, or Hispanic; having low income; and being unable to work. The perception of risk of exposure to EMFs through the use of hair dryers (vs. exposure to power and distribution lines) was the factor the most associated with self-reporting about hypersensitivity to EMFs. However, risk perception was not sufficient to explain the characteristics of people reporting this disorder.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241215/

Additional Resources

Updated: November 5, 2017

Andrianome et al. Increasing levels of saliva alpha amylase in electrohypersensitive (EHS) patients.Int J Radiat Biol. 2017 Aug;93(8):841-848. https://www.ncbi.nlm.nih.gov/pubmed/28466664

Anonymous. Testimony from an internist about her two electrosensitive children to the Joint Committee on Education, Commonwealth of Massachusetts. Sep 4, 2017. http://bit.ly/MDtestifyMass

Bray, R. Trials and trends in caring for patients with electromagnetic hypersensitivity at Ontario's Environmental Health Clinic. WSF Montreal. Aug 13 2016. https://maisonsaine.ca/wp-content/uploads/2016/09/ehs-bray-13-08-2016.pdf

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Labels: cell towers, cordless phone, EHS, electrical sensitivity, electro-sensitive, electromagnetic hypersensitivity, electrosensitivity, Europe, hearing, mobile phone, occupational health, public, SB 649, Wi-Fi, workers

Newer Post Home Older Post

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Monday, October 10, 2016

Does Wireless Radiation from Cell Phones and Wi-Fi Cause Alzheimer's Disease?

Microwaves and Alzheimer's disease

Oct 6, 2016

The following paper discusses the research which suggests that long-term exposure to cell phone & other wireless radiation (e.g., Wi-Fi) may cause Alzheimer's Disease. The paper was published in the peer-reviewed journal, ***Experimental and Therapeutic Medicine.***

The paper is open access and can be viewed or downloaded from the link below.

Zhang X, Huang WJ, Chen WW. Microwaves and Alzheimer's disease. Exp Ther Med. 2016 Oct;12(4):1969-1972.

Abstract

Alzheimer's diseases (AD) is the most common type of dementia and a neurodegenerative disease that occurs when the nerve cells in the brain die. The cause and treatment of AD remain unknown. However, AD is a disease that affects the brain, an organ that controls behavior. Accordingly, anything that can interact with the brain may affect this organ positively or negatively, thereby protecting or encouraging AD. In this regard, modern life encompasses microwaves for all issues including industrial, communications, medical and domestic tenders, and among all applications, the cell phone wave, which directly exposes the brain, continues to be the most used. Evidence suggests that microwaves may produce various biological effects on the central nervous system (CNS) and many arguments relay the possibility that microwaves may be involved in the pathophysiology of CNS disease, including AD. By contrast, previous studies have reported some beneficial cognitive effects and that microwaves may protect against cognitive impairment in AD. However, although many of the beneficial effects of microwaves are derived from animal models, but can easily be extrapolated to humans, whether microwaves cause AD is an important issue that is to be addressed in the current review.

Conclusion

The impact of wireless communication on human health is a matter of debate. Since there are widespread concerns regarding the deleterious effects of the exposure to microwaves on human tissues and the subsequent potential threat of carcinogenesis, we can conclude that the current exposure to microwaves during the use of cell phones is not safe for long-term exposure, despite the current scientific opinion. Absorption of the cell phone signal into the brain of children does not exclude serious neuronal damage, as evidenced in rat studies (50). In addition, the increased risk of tumors of the head associated with long-term cell phone use is evident since radiofrequency may cause the blood-brain barrier to leak and to favor the damage of genetic material which consists of common precursors to cancer (51). Accordingly, poor fertility and the increased chance of miscarriage and childhood cancer have been associated with cell phone storage in front pockets. Notably, the data suggested that the hippocampus can be injured by long-term microwave exposure (52), which may result in the impairment of cognitive function due to neurotransmitter disruption. These results suggest that precautionary approach underlying the restrictive use of cell phones constitutes essential appropriate guidelines to follow although additional studies are needed.

Open Access Paper: http://bit.ly/ADwireless

Also see:

Blood-brain barrier studies
Key cell phone radiation research studies
Potential biologic mechanism

References

Hallberg Ö, Johansson O. Alzheimer mortality - why does it increase so fast in sparsely populated areas? Europ Biol Bioelectromag 2005; 1: 225-246. http://bit.ly/Alz2005

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Labels: Alzheimer's Disease, blood-brain barrier, hippocampus, review, wireless radiation

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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

- bg - български
- es - español
- cs - čeština
- da - dansk
- de - Deutsch
- et - eesti keel
- el - ελληνικά
- en - English (Selected)
- fr - français
- ga - Gaeilge
- hr - hrvatski
- it - italiano
- lv - latviešu valoda
- lt - lietuvių kalba
- hu - magyar
- mt - Malti
- nl - Nederlands
- pl - polski
- pt - português
- ro - română
- sk - slovenčina
- sl - slovenščina
- fi - suomi
- sv - svenska

Index | Previous | Next | Full text

Procedure : 2008/2211(INI) — Document stages in plenary

Document selected : A6-0089/2009

Texts tabled :	Debates :	Votes :	Texts adopted :
A6-0089/2009	PV 01/04/2009 - 23 CRE 01/04/2009 - 23	PV 02/04/2009 - 9.24 Explanations of votes Explanations of votes	P6_TA(2009)0216

Texts adopted

103k 51k

Thursday, 2 April 2009 - Brussels — **Final edition**

Health concerns associated with electromagnetic fields P6_TA(2009)0216 A6-0089/2009

European Parliament resolution of 2 April 2009 on health concerns associated with electromagnetic fields (2008/2211(INI))

The European Parliament ,

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

– having regard to Articles 137, 152, and 174 of the EC Treaty, seeking to promote a high level of human health, environmental protection and workers' health and safety protection,

– having regard to Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)[1] and the related Commission implementation report of 1 September 2008 on the implementation of that recommendation (COM(2008)0532),

– having regard to Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004 on the minimum health and safety requirements regarding exposure of workers to the risks arising from physical agents (electromagnetic fields)[2] ,

– having regard to Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity[3] and to the respective harmonised safety standards for mobile phones and base stations,

– having regard to Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits[4] ,

– having regard to its resolution of 4 September 2008 on the mid-term review of the European Environment and Health Action Plan 2004-2010[5] ,

– having regard to its position of 10 March 1999 on the proposal for a Council Recommendation on the limitation of exposure of the general public to electromagnetic fields 0 Hz – 300 GHz[6] ,

– having regard to Rule 45 of its Rules of Procedure,

– having regard to the report of the Committee on the Environment, Public Health and Food Safety (A6-0089/2009),

A. whereas electromagnetic fields (EMFs) exist in nature and have consequently always been present on earth; whereas, however, in recent decades, environmental exposure to man-made sources of EMFs has risen constantly, driven by demand for electricity, increasingly more specialised wireless technologies, and changes in the organisation of society; whereas the end effect is that every individual is now being exposed to a complex mixture of electric and magnetic fields of different frequencies, both at home and at work,

B. whereas wireless technology (mobile phones, Wi-Fi/WiMAX, Bluetooth, DECT landline telephones) emits EMFs that may have adverse effects on human health,

C. whereas most European citizens, especially young people aged from 10 to 20, use a mobile phone, an object serving a practical purpose and as a fashion accessory, and whereas there are continuing uncertainties about the possible health risks, particularly to young people whose brains are still developing,

D. whereas the dispute within the scientific community regarding the potential health risks arising from EMFs has intensified since 12 July 1999, when exposure limits for fields in the 0 Hz to 300 GHz range were laid down in Recommendation 1999/519/EC,

E. whereas the fact that the scientific community has reached no definite conclusions has not prevented some national or regional governments, in China, Switzerland, and Russia, as well as in at least nine EU Member States, from setting what are termed "preventive" exposure limits, that is to say, lower than those advocated by the Commission and its independent scientific committee, the Scientific Committee on Emerging and Newly Identified Health Risks[7] ,

F. whereas actions to limit the exposure of the general public to EMFs should be balanced against improvements to quality of life, in terms of safety and security, brought about by devices transmitting EMFs,

G. whereas among the scientific projects arousing both interest and controversy is the Interphone epidemiological study, financed by an EU contribution of EUR 3 800 000, primarily under the Fifth RTD Framework Programme[8] , the findings of which have been awaited since 2006,

H. whereas, however, there are some points that appear to be the subject of general agreement, in particular the idea that reactions to microwave exposure vary from one person to another, the need, as a matter of priority, to conduct exposure tests under actual conditions in order to assess the non-thermal effects associated with radio-frequency (RF) fields, and the fact that children exposed to EMFs are especially vulnerable[9] ,

I. whereas the EU has laid down exposure limits to protect workers from the effects of EMFs; whereas on the basis of the precautionary principle such measures should also be taken for the sections of population concerned, such as residents and consumers,

J. whereas the Special Eurobarometer report on Electromagnetic Fields (No 272a of June 2007) indicates that the majority of citizens do not feel that the public authorities inform them adequately on measures to protect them from EMFs,

K. whereas it is necessary to continue investigations into intermediate and very low frequencies so that conclusions can be drawn as to their effects on health,

L. whereas the use of Magnetic Resonance Imaging (MRI) must not be threatened by Directive 2004/40/EC as MRI technology is at the cutting edge of research, diagnosis and treatment of life-threatening diseases for patients in Europe,

M. whereas the MRI safety standard IEC/EN 60601-2-33 establishes limit values for EMFs which have been set so that any danger to patients and workers is excluded.

1. Urges the Commission to review the scientific basis and adequacy of the EMF limits as laid down in Recommendation 1999/519/EC and report to the Parliament; calls for the review to be undertaken by the Scientific Committee on Emerging and Newly Identified Health Risks;

2. Calls for particular consideration of biological effects when assessing the potential health impact of electromagnetic radiation, especially given that some studies have found the most harmful effects at lowest levels; calls for active research to address potential health problems by developing solutions that negate or reduce the pulsating and amplitude modulation of the frequencies used for transmission;

3. Maintains that as well as, or as an alternative to, amending European EMFs limits, the Commission, working in coordination with experts from Member States and the industries concerned (electricity companies, telephone operators and manufacturers of electrical appliances including mobile phones), should draw up a guide to available technology options serving to reduce exposure to EMFs;

4. Notes that industry stakeholders as well as relevant infrastructure managers and competent authorities can already influence certain factors, for example setting provisions with regards to the distance between a given site and the transmitters, the height of the site in relation to the height of the base station, or the direction of a transmitting antenna in relation to living environments, and, indeed, should obviously do so in order to reassure, and afford better protection to, the people living close to such facilities; calls for optimal placement of masts and transmitters and further calls for the sharing of masts and transmitters placed in this way by providers so as to limit the proliferation of poorly positioned masts and transmitters; calls on the Commission and Member States to draw up appropriate guidance;

5. Invites the Member States and local and regional authorities to create a one-stop shop for authorisation to install antennas and repeaters, and to include among their urban development plans a regional antenna plan

6. Urges the authorities responsible for authorising the siting of mobile telephony antennas to reach agreement, jointly with the operators in that sector, on the sharing of infrastructure, in order to reduce the volume thereof and the exposure of the public to EMFs;

7. Acknowledges the efforts of mobile communications and other EMF-transmitting wireless technologies to avoid damaging the environment, and in particular to address climate change;

8. Considers that, given the increasing numbers of legal actions and measures by public authorities having the effect of a moratorium on the installation of new EMF-transmitting equipment, it is in the general interest to encourage solutions based on negotiations involving industry stakeholders, public authorities, military authorities and residents" associations to determine the criteria for setting up new GSM antennas or high-voltage power lines, and to ensure at least that schools, crèches, retirement homes, and health care institutions are kept clear, within a specific distance determined by scientific criteria, of facilities of this type;

9. Calls on the Member States to make available to the public, jointly with the operators in the sector, maps showing exposure to high-voltage power lines, radio frequencies and microwaves, and especially those generated by telecommunications masts, radio repeaters and telephone antennas. Calls for that information to be displayed on an internet page so that it can easily be consulted by the public, and for it to be disseminated in the media;

10. Proposes that the Commission consider the possibility of using funding from the Trans-European Energy Networks to investigate the effects of EMFs at very low frequencies, and particularly in electrical power lines,

11. Calls on the Commission, during the 2009-2014 parliamentary term, to launch an ambitious programme to gauge the electromagnetic compatibility between waves created artificially and those emitted naturally by the human body with a view to determining whether microwaves might ultimately have undesirable consequences for human health;

12. Calls on the Commission to present a yearly report on the level of electromagnetic radiation in the EU, its sources, and actions taken in the EU to better protect human health and the environment;

13. Calls on the Commission to find a solution enabling Directive 2004/40/EC to be implemented more rapidly and thus ensure that workers are properly protected against EMFs, just as they are already protected under two other Community acts against noise[10] and vibration[11] and to introduce a derogation for MRI under Article 1 of that Directive.

14. Deplores the fact that, as a result of repeated postponements since 2006, the findings of the Interphone study have yet to be published, the purpose of this international epidemiological study being to establish whether there is a link between use of mobile phones and certain types of cancer, including brain, auditory nerve, and parotid gland tumours;

15. Draws attention in this context to the appeal for caution from the coordinator of the Interphone study, Elisabeth Cardis, who, in the light of existing knowledge, recommends, as far as children are concerned, that mobile phones should not be used beyond reasonable limits and that landlines should be preferred;

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

16. Believes in any event that it is up to the Commission, which has an important contribution to the financing of this global study, to ask those in charge of the project why no definitive findings have been published and, should it receive an answer, to inform Parliament and the Member States without delay;

17. Also suggests to the Commission, to make for efficiency in policy and budget terms, that the Community funding earmarked for studies on EMFs be partly switched to finance a wide-ranging awareness campaign to familiarise young Europeans with good mobile phone techniques, such as the use of hands-free kits, keeping calls short, switching off phones when not in use (such as when in classes) and using phones in areas that have good reception;

18. Considers that such awareness-raising campaigns should also familiarise young Europeans with the health risks associated with household devices and the importance of switching off devices rather than leaving them on stand-by;

19. Calls on the Commission and Member States to increase research and development funding for the evaluation of potential long-term adverse effects of mobile telephony radio frequencies; calls also for an increase in public calls for proposals for investigation of the harmful effects of multiple exposure to different sources of EMFs, particularly where children are concerned;

20. Proposes that the European Group on Ethics in Science and New Technologies be given the additional task of assessing scientific integrity in order to help the Commission forestall possible cases of risk, conflict of interests, or even fraud that might arise now that competition for researchers has become keener;

21. Calls on the Commission, in recognition of the public concern in many Member States, to work with all relevant stakeholders, such as national experts, non-governmental organisations and industrial sectors, to improve the availability of, and access to, up-to-date information understandable to non-specialists on wireless technology and protection standards;

22. Calls on the International Commission on Non-Ionising Radiation Protection and the World Health Organisation (WHO) to be more transparent and open to dialogue with all stakeholders in standard setting;

23. Condemns certain particularly aggressive marketing campaigns by telephone operators in the run-up to Christmas and other special occasions, including for example the sale of mobile phones designed solely for children or free call time packages aimed at teenagers;

24. Proposes that the EU's indoor air quality policy should encompass the study of "wireless" domestic appliances, which, like Wi-Fi for Internet access and digital enhanced cordless telecommunications (DECT) telephones, have been widely adopted in recent years in public places and in the home, with the result that citizens are being continuously exposed to microwave emissions;

25. Calls, given its constant concern to improve consumer information, for the technical standards of the European Committee for Electrotechnical Standardisation to be amended with a view to imposing labelling requirements whereby the transmitting power would have to be specified and every wireless-operated device accompanied by an indication that it emitted microwaves;

26. Calls on the Council and Commission, in coordination with the Member States and the Committee of the Regions, to encourage the introduction of a single standard designed to ensure that local residents are subjected to as low a degree of exposure as possible when high-voltage grids are extended;

27. Is greatly concerned about the fact that insurance companies are tending to exclude coverage for the risks associated with EMFs from the scope of liability insurance policies, the implication clearly being that European insurers are already enforcing their version of the precautionary principle;

28. Calls on Member States to follow the example of Sweden and to recognise persons that suffer from electrohypersensitivity as being disabled so as to grant them adequate protection as well as equal opportunities;

29. Instructs its President to forward this resolution to the Council, the Commission, the governments and parliaments of the Member States, the Committee of the Regions, and the WHO.

(1) OJ L 199, 30.7.1999, p. 59.
(2) OJ L 159, 30.4.2004, p. 1.
(3) OJ L 91, 7.4.1999, p. 10.
(4) OJ L 374, 27.12.2006, p. 10.
(5) Texts adopted, P6_TA(2008)0410.
(6) OJ C 175, 21.6.1999, p. 129.
(7) Opinion of 21 March 2007 adopted at the 16th plenary meeting of the Committee.
(8) Quality of life programme, contract No QLK4-1999-01563.
(9) March 2001 STOA study on "The physiological and environmental effects of non-ionising EMR", PE297.574.
(10) Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (OJ L 42, 15.2.2003, p. 38).
(11) Directive 2002/44/EC of the European Parliament and of the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) (OJ L 177, 6.7.2002, p. 13).

Last updated: 8 December 2009 **Legal notice**

Scientists warn of potential serious health effects of 5G

September 13, 2017

We the undersigned, more than 180 scientists and doctors from 35 countries, recommend a moratorium on the roll-out of the fifth generation, 5G, for telecommunication until potential hazards for human health and the environment have been fully investigated by scientists independent from industry. 5G will substantially increase exposure to radiofrequency electromagnetic fields (RF-EMF) on top of the 2G, 3G, 4G, Wi-Fi, etc. for telecommunications already in place. RF-EMF has been proven to be harmful for humans and the environment.

(Note: Blue links below are references.)

5G leads to massive increase of mandatory exposure to wireless radiation

5G technology is effective only over short distance. It is poorly transmitted through solid material. Many new antennas will be required and full-scale implementation will result in antennas every 10 to 12 houses in urban areas, **thus massively increasing mandatory exposure.**

With "the ever more extensive use of wireless technologies," nobody can avoid to be exposed. Because on top of the increased number of 5G-transmitters (even within housing, shops and in hospitals) according to estimates, "10 to 20 billion connections" (to refrigerators, washing machines, surveillance cameras, self-driving cars and buses, etc.) will be parts of the Internet of Things. All these together can cause a substantial increase in the total, long term RF-EMF exposure to all EU citizens.

Harmful effects of RF-EMF exposure are already proven

More than 230 scientists from 41 countries have expressed their "serious concerns" regarding the ubiquitous and increasing exposure to EMF generated by electric and wireless devices already before the additional 5G roll-out. They refer to the fact that "numerous recent scientific publications have shown that *EMF affects living organisms at levels well below most international and national guidelines*". Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plants and animals.

After the scientists' appeal was written in 2015 additional research has convincingly confirmed serious health risks from RF-EMF fields from wireless technology. The world's largest study (25 million US dollar) National Toxicology Program (NTP), shows statistically significant increase in the incidence of *brain and heart cancer* in animals exposed to EMF below the ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines followed by most countries. These results support results in human epidemiological studies on RF radiation and brain tumour risk. A large number of peer-reviewed scientific reports demonstrate harm to human health from EMFs.

The International Agency for Research on Cancer (IARC), the cancer agency of the World Health Organization (WHO), in 2011 concluded that EMFs of frequencies 30 KHz – 300 GHz are possibly carcinogenic to humans (Group 2B). However, new studies like the NTP study mentioned above and several epidemiological investigations including the latest studies on mobile phone use and brain cancer risks confirm that RF-EMF radiation is carcinogenic to humans.

The EUROPA EM-EMF Guideline 2016 states that "there is strong evidence that *long-term exposure to certain EMFs is a risk factor for diseases* such as certain cancers, Alzheimer's disease, and male infertility...Common EHS (electromagnetic hypersensitivity) symptoms include headaches, concentration difficulties, sleep problems, depression, lack of energy, fatigue, and flu-like symptoms."

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

An increasing part of the European population is affected by ill health symptoms that have for many years been linked to exposure to EMF and wireless radiation in the scientific literature. The International Scientific Declaration on EHS & multiple chemical sensitivity (MCS), Brussels 2015, declares that: "In view of our present scientific knowledge, we thereby stress all national and international bodies and institutions...to recognize EHS and MCS as true medical conditions which acting as sentinel diseases may create a *major public health concern in years to come worldwide* i.e. in all the countries implementing unrestricted use of electromagnetic field-based wireless technologies and marketed chemical substances... ***Inaction is a cost to society*** and is not an option anymore... we unanimously acknowledge this serious hazard to public health...that major primary *prevention measures are adopted and prioritized, to face this* ***worldwide pan-epidemic*** *in perspective."*

Precautions

The **Precautionary Principle** (UNESCO) was adopted by EU 2005: *"When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain,* actions shall be taken to *avoid or diminish that harm."*

Resolution 1815 (Council of Europe, 2011): *"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...Assembly strongly recommends that the ALARA (as low as reasonably achievable) principle is applied, covering both the so-called thermal effects and the athermic [non-thermal] or biological effects of electromagnetic emissions or radiation" and to "improve risk-assessment standards and quality".

The **Nuremberg code** (1949) applies to all experiments on humans, thus including the roll-out of 5G with new, higher RF-EMF exposure. All such experiments: "should be based on previous knowledge (e.g., an expectation derived from animal experiments) that justifies the experiment. No experiment should be conducted, *where there is an a priori reason to believe that death or disabling injury will occur*; except, perhaps, in those experiments where the experimental physicians also serve as subjects." (Nuremberg code pts 3-5). Already published scientific studies show that there is "a priori reason to believe" in real health hazards.

The **European Environment Agency** (EEA) is warning for "Radiation risk from everyday devices" in spite of the radiation being below the WHO/ICNIRP standards. EEA also concludes: "There are many examples of the failure to use the precautionary principle in the past, which have *resulted in serious and often irreversible damage to health and environments*...harmful exposures can be widespread before there is both 'convincing' evidence of harm from long-term exposures, and biological understanding [mechanism] of how that harm is caused."

"Safety guidelines" protect industry – not health

The current ICNIRP "safety guidelines" are obsolete. All proofs of harm mentioned above arise although the radiation is below the ICNIRP "safety guidelines". Therefore new safety standards are necessary. The reason for the misleading guidelines is that "conflict of interest of ICNIRP members due to their *relationships with telecommunications or electric companies* undermine the impartiality that should govern the regulation of Public Exposure Standards for non-ionizing radiation...To evaluate cancer risks it is necessary to include scientists with competence in medicine, especially oncology."

The current ICNIRP/WHO guidelines for EMF are based on the obsolete hypothesis that "The critical effect of RF-EMF exposure relevant to human health and safety is heating of exposed tissue." However, scientists have proven that many different kinds of *illnesses and harms are* caused without heating ("non-thermal effect") at radiation levels well below ICNIRP guidelines.

We urge the EU:

1) To take all reasonable measures to halt the 5G RF-EMF expansion until independent scientists can assure that 5G and the total radiation levels caused by RF-EMF (5G together with 2G, 3G, 4G, and WiFi) will not be harmful for EU-citizens, especially infants, children and pregnant women, as well as the environment.

2) To recommend that all EU countries, especially their radiation safety agencies, follow Resolution 1815 and inform citizens, including, teachers and physicians, about health risks from RF-EMF radiation, how and why to avoid wireless communication, particularly in/near e.g., daycare centers, schools, homes, workplaces, hospitals and elderly care.

3) To appoint immediately, without industry influence, an EU task force of independent, truly impartial EMF-and-health scientists with no conflicts of interest[1] to re-evaluate the health risks and:

a) To decide about new, safe "maximum total exposure standards" for all wireless communication within EU.

b) To study the total and cumulative exposure affecting EU-citizens.

c) To create rules that will be prescribed/enforced within the EU about how to avoid exposure exceeding new EU "maximum total exposure standards" concerning all kinds of EMFs in order to protect citizens, especially infants, children and pregnant women.

4) To prevent the wireless/telecom industry through its lobbying organizations from persuading EU-officials to make decisions about further propagation of RF radiation including 5G in Europe.

5) To favor and implement wired digital telecommunication instead of wireless.

We expect an answer from you no later than **October 31, 2017** to the two first mentioned signatories about what measures you will take to protect the EU-inhabitants against RF-EMF and especially 5G radiation. This appeal and your response will be publicly available.

Respectfully submitted,

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WE will add signatories to the following list through the end of 2017. The updated list of signatories and the appeal can be found later HERE.

[1] Avoid similar mistakes as when the Commission (2008/721/EC) appointed industry supportive members for SCENIHR, who submitted to EU a misleading SCENIHR report on health risks, giving telecom industry a clean bill to irradiate EU-citizens. The report is now quoted by radiation safety agencies in EU.

Signatories to the 5G Appeal

(As of September 13, 2017)

Note: The endorsements are personal and not necessarily supported by the affiliated universities or organizations.

EU and European Nations

AUSTRIA

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The Porto Alegre Resolution

We, the undersigned scientists, were honored to participate in a workshop organized by the Universidade Federal do Rio Grande do Sul and the Public Ministry of Rio Grande do Sul and sponsored by the Brazilian Health Ministry, the International Commission for Electromagnetic Safety, the Porto Alegre Environmental Council (COMAM/PA), the Rio Grande do Sul Center for Health Vigilance (CEVS/RS) and others, entitled, "International Workshop on Non-Ionizing Radiation, Health and Environment" which took place on May 18 and 19, 2009, in Porto Alegre, Brazil.

This resolution follows several international resolutions agreed to by concerned scientists and medical doctors over the past decade, including resolutions developed by the International Commission for Electromagnetic Safety [1], based on evidence and consideration on documents such as the BioInitiative Report [2] and a special issue of the journal Pathophysiology on electrical and magnetic fields, published in August 2009 [3].

We agreed that the protection of health, well-being and the environment requires immediate adoption of the Precautionary Principle, which states, "*when there are indications of possible adverse effects, though they remain uncertain, the risks from doing nothing may be far greater than the risks of taking action to control these exposures. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it*", until new scientific discoveries are recognized as the only criterion for the establishment or modification of non-ionizing radiation exposure standards;

We recognize that, in Brazil as well as all over the world, where there has been an unprecedented explosion in the availability and use of non-ionizing electromagnetic fields for electrical and wireless communications technologies (mobile and cordless phones, WiFi and WIMAX networks, RFID, etc,), as well as major electrical grid and wireless broadband infrastructure changes, this assessment should inform risk management to take proper steps to protect the public from long-term, low-level exposure to extremely-low frequency as well as radiofrequency electromagnetic fields that have substantially increased in the ambient environment in recent years.

We are concerned about the body of evidence that indicates that exposure to electromagnetic fields interferes with basic human biology and may increase the risk of cancer and other chronic diseases. The exposure levels at which these effects have been observed are many times lower than the standards promulgated by the International Commission for Non-Ionizing radiation Protection (ICNIRP) [4] and the IEEE's International Committee on Electromagnetic Safety (ICES) [5]. These standards are obsolete and were derived from biological effects of short-term high intensity exposures that cause health effects by temperature elevation and nerve excitation discovered decades ago. Recent research indicates that electromagnetic fields could cause detrimental health effects even at very low levels of exposure. The ICNIRP and IEEE/ICES standards are being supported and promoted by interested parties to avoid precautionary technical planning, precautionary laws, and precautionary advice to the public.

We are deeply concerned that current uses of non-ionizing radiation for mobile phones, wireless computers and other technologies place at risk the health of children and teens, pregnant women, seniors and others who are most vulnerable due to age or disability, including a health condition known as electromagnetic hypersensitivity. We strongly recommend these precautionary practices:

1. Children under the age of 16 should not use mobile phones and cordless phones, except for emergency calls;

2. The licensing and/or use of Wi-Fi, WIMAX, or any other forms of wireless communications technology, indoors or outdoor, shall preferably not include siting or signal transmission in residences, schools, day-care centers, senior centers, hospitals or any other buildings where people spend considerable time;

3. The licensing for siting and installation of infrastructure related to electrical power and wireless broadband telecommunications, particularly, cellular telephony, Wi-Fi and WIMAX, should only be approved after open public hearings are held and approval granted with full consideration given to the need to apply the Precautionary Principle. Sensitive areas should be avoided to protect vulnerable populations;

4. Mankind shall be encouraged to continue to discover new means of harnessing non-ionizing electromagnetic energy, aiming at bringing benefits to society, through definition of new standards of human exposure, which are based on the biological realities of nature and not solely on the consideration of economic and technological needs.

We, therefore, urge all nations to join Switzerland, Italy, Belgium, Russia China, the U.S. (for the FCC standard for partial exposure of the head) and other countries and regions that have chosen to adopt a more precautionary strategy, aiming to assure more safety to the public while maintaining good service quality.

We make an urgent call to all nations to convene a panel of experts, selected from candidates recommended by civil society groups (not only those preferred by the affected industries) to discuss precautionary technology, laws and advice in order to develop policies that reconcile public health concerns with further development of wireless communications technology such as mobile phones as well as electric power transmission and distribution systems.

Citations:
[1] ICEM's Benevento Resolution (2006) and Venice Resolution (2008) www.icems.eu.
[2] BioInitiative Report www.bioinitiative.org
[3] A Special Issue of Pathophysiology on the science and public health/policy issues regarding Electromagnetic Fields was published March 2009, and is the only peer reviewed scientific journal referenced on this list. It is now available online at http://www.sciencedirect.com/science/journal/09284680
[4] International Commission on Non-ionizing Radiation Protection www.icnirp.de
[5] Institute of Electrical and Electronics Engineers. www.ieee.org.

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Rev Environ Health. 2015;30(4):209-15. doi: 10.1515/reveh-2015-0012.

Electromagnetic hypersensitivity--an increasing challenge to the medical profession.

Hedendahl L, Carlberg M, Hardell L.

Abstract

BACKGROUND: In 1970, a report from the former Soviet Union described the "microwave syndrome" among military personnel, working with radio and radar equipment, who showed symptoms that included fatigue, dizziness, headaches, problems with concentration and memory, and sleep disturbances. Similar symptoms were found in the 1980s among Swedes working in front of cathode ray tube monitors, with symptoms such as flushing, burning, and tingling of the skin, especially on the face, but also headaches, dizziness, tiredness, and photosensitivity. The same symptoms are reported in Finns, with electromagnetic hypersensitivity (EHS) being attributed to exposure to electromagnetic fields (EMF). Of special concern is involuntary exposure to radiofrequency (RF)-EMF from different sources. Most people are unaware of this type of exposure, which has no smell, color, or visibility. There is an increasing concern that wireless use of laptops and iPads in Swedish schools, where some have even abandoned textbooks, will exacerbate the exposure to EMF.

METHODS: We have surveyed the literature on different aspects of EHS and potential adverse health effects of RF-EMF. This is exemplified by case reports from two students and one teacher who developed symptoms of EHS in schools using Wi-Fi.

RESULTS: In population-based surveys, the prevalence of EHS has ranged from 1.5% in Sweden to 13.3% in Taiwan. Provocation studies on EMF have yielded different results, ranging from where people with EHS cannot discriminate between an active RF signal and placebo, to objectively observed changes following exposure in reactions of the pupil, changes in heart rhythm, damage to erythrocytes, and disturbed glucose metabolism in the brain. The two students and the teacher from the case reports showed similar symptoms, while in school environments, as those mentioned above.

DISCUSSION: Austria is the only country with a written suggestion to guidelines on the diagnosis and treatment of EMF-related health problems. Apart from this, EHS is not recognized as a specific diagnosis in the rest of the world, and no established treatment exists.

CONCLUSION: It seems necessary to give an International Classification of Diseases to EHS to get it accepted as EMF-related health problems. The increasing exposure to RF-EMF in schools is of great concern and needs better attention. Longer-term health effects are unknown. Parents, teachers, and school boards have the responsibility to protect children from unnecessary exposure.

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

PMID: 26372109 DOI: 10.1515/reveh-2015-0012

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure f
cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Friday, December 1, 2017

National Toxicology Program Finds Cell Phone Radiation Causes Cancer

Dec 1, 2017

Microwave News reported today that the vice-chair of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), Maria Feychting, has been trying to convince the scientific community to dismiss the $25 million cell phone cancer study conducted by the U.S. National Toxicology Program (NTP).

According to *Microwave News*, Feychting claimed at scientific meetings held in Germany and Sweden last month that the pathology analyses in the NTP study were not properly blinded. This issue was originally raised by an official reviewer of the study and was laid to rest in the NTP interim report released in May, 2016.

Several researchers in the U.S. and Europe expressed their concerns to *Microwave News* about Feychting's misguided efforts to undermine the credibility of the NTP cell phone study.

The *Microwave News* article reports that Feychting's declaration of personal interests filed with ICNIRP is incomplete as she has not fully disclosed potential conflicts of interest due to her role in the Swedish COSMOS study which has industry funding.

For more information see *Microwave News*.

Nov 28, 2017

NIEHS updates its cell phone information page

This month the National Toxicology Program (NTP) of the **National Institute of Environmental Health Sciences** (NIEHS) **updated the cell phone information page** on its website and the **fact sheet** which summarizes the NTP cell phone radiation study. See below for a summary of the study and its findings.

The NTP's website indicates that the NIEHS has warned its "federal regulatory partners" (i.e., the Federal Communications Commission and the Food and Drug Administration) that the NTP's research found that cell phone radiation caused cancer in male rats to enable these agencies to provide the latest guidance to the public about safe ways to use cell phones and other radiofrequency radiation-emitting devices.

Following is some of the language which now appears on the NTP website.

Joel M. Moskowitz, Ph.D.
Director
Center for Family and Community Heal
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety

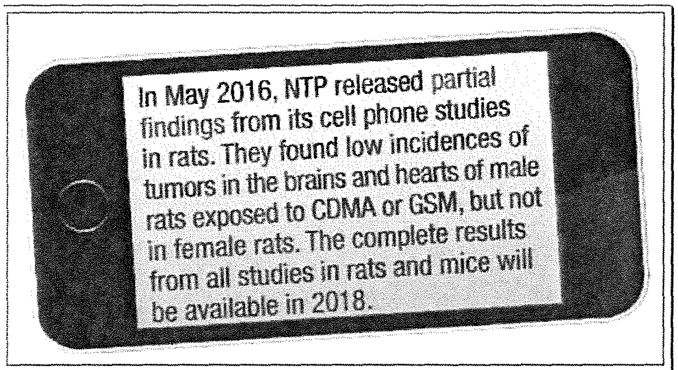
- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

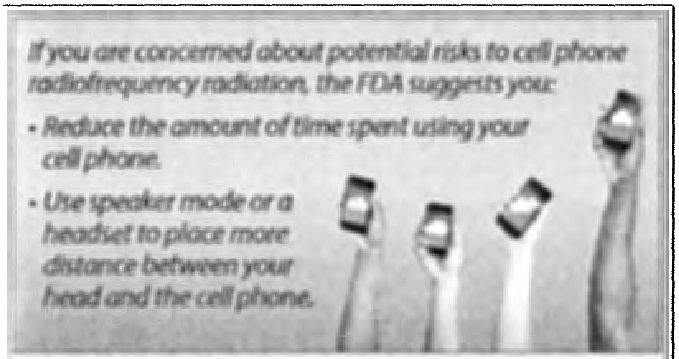
Archive

Here are some key points about the cell phone study:

- The nomination for NTP to study cell phone radiofrequency radiation was made by the U.S. Food and Drug Administration.
- These are the largest, most complex studies ever conducted by NTP.
- For the studies, rats and mice were exposed to frequencies and modulations currently used in cellular communications in the United States. The rodents were exposed for 10-minute on, 10-minute off increments, totaling just over 9 hours a day from before birth through 2 years of age.
- NTP found low incidences of tumors in the brains and hearts of male rats, but not in female rats. Studies in mice are continuing.
- NTP has provided these findings to its federal regulatory partners to enable them to have the latest information for public health guidance about safe ways to use cellular telephones and other radiofrequency radiation emitting devices.
- Previous human, observational data collected in earlier, large-scale population-based studies have found limited evidence of an increased risk for developing cancer from cell phone use.

The updated NTP **fact sheet** includes the following two graphics.





Nov 21, 2017

Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice

McCormick D. Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice. Toxicology Letters. 280 (Suppl. 1): S31. Oct 20, 2017. https://doi.org/10.1016/j.toxlet.2017.07.07

Epidemiology data concerning possible health effects of exposure to radiofrequency fields (RF) are conflicting. For this reason, well-designed and controlled studies in predictive laboratory animal models provide the best prospective opportunity to identify effects of RF exposure that may translate into human health hazards.

The U.S. National Toxicology Program supported a program in our laboratory to identify and characterize effects of acute, subchronic, and chronic exposure to non-thermal levels of RF in Sprague-Dawley rats and B6C3F1 mice.

Five-day pilot studies were performed to identify the maximum Specific Absorption Ratios (SARs) to which juvenile, adult, and pregnant rodents can be exposed without increasing body temperature by >1.0 °C.

Subsequent subchronic (ten-week) toxicity studies failed to identify any toxicologically significant effects of non-thermal RF on survival, body weight, clinical signs, hematology, or gross or microscopic pathology.

Two-year studies were performed to determine if exposure to non-thermal levels of RF increases the incidence of neoplasia in any site. Male rats exposed to RF demonstrated significantly increased incidences of glioma (brain) and schwannoma (heart); these increases were not seen in female rats or in either sex of mice.

Gliomas and schwannomas have been identified in some epidemiology studies as possible RF-induced neoplasms. Considering (a) the conflicting results of RF epidemiology studies and (b) the lack of generally accepted biophysical or molecular mechanisms through which RF could induce or promote neoplasia, data from animal bioassays will play a central role in "weight-of-the-evidence" assessments of the possible health effects of RF exposure.

http://www.sciencedirect.com/science/article/pii/S0378427417303120?via%3Dihub

Sep 20, 2017

Scientists from the National Toxicology Program presented their data on the genotoxicity of cell phone radiation in rats and mice at the annual meeting of the Environmental Mutagenesis and Genomics Society held in Raleigh, North Carolina from September 9-13, 2017.

Male and female rats and mice were exposed to 2G cell phone radiation, either CDMA or GSM, for 18 hours per day in 10 minute intervals. The rats were exposed to cell phone radiation at 1.5, 3, or 6 W/kg specific absorption rate (SAR) for 19 weeks from gestation day 5. The mice were exposed to radiation at 2.5, 5, or 10 W/kg SAR for 13 weeks from postnatal day 5.

DNA damage was assessed in three brain regions, in liver cells and in blood leukocytes using the comet assay. Chromosomal damage was assessed in peripheral blood erythrocytes using the micronucleus assay.

DNA damage was significantly increased:

- in the frontal cortex of male mice from either CDMA or GSM cell phone radiation exposure,
- in peripheral leukocytes of female mice from CDMA exposure, and
- in the hippocampus of male rats from CDMA exposure.

There were no significant increases in micronucleated red blood cells in rats or mice.

The authors concluded that, "exposure to RFR [radio frequency radiation] has the potential to induce measurable DNA damage under certain exposure conditions."

The NTP is scheduled to publish a complete report about its cell phone radiation studies in early 2018. The FDA called for this research in 1999.

Here is the abstract for this presentation.

P36

Evaluation of the Genotoxicity of Cell Phone Radiofrequency Radiation in Male and Female Rats and Mice Following Subchronic Exposure. Smith-Roe, SL1, Wyde ME[1], Stout MD[1], Winters JW[2], Hobbs CA[2], Shepard KG[2], Green AS[2], Kissling GA[1], Tice RR[1], Bucher JR[1], Witt KL[1], [1]NIEHS/NIH, Research Triangle Park, NC, United States, [2]Integrated Laboratory Systems, Inc., Research Triangle Park, NC, United States.

The National Toxicology Program tested the two common radiofrequency radiation (RFR) modulations emitted by cellular telephones in a 2-year rodent cancer bioassay that included additional animal cohorts for interim assessments of genotoxicity endpoints. Male and female Sprague Dawley rats and B6C3F1/N mice were exposed from gestation day 5 or postnatal day 35, respectively, to code division multiple access (CDMA) or global system for mobile (GSM) modulations semi-continuously for 18 h/day in 10 min intervals in reverberation chambers at specific absorption rates (SAR) of 1.5, 3, or 6 W/kg (rats) or 2.5, 5, or 10 W/kg (mice). Rats and mice were exposed at 900 MHz or 1900 MHz, respectively. The interim cohorts, 5 animals per treatment group, were examined after 19 (rats) or 13 (mice) weeks of exposure for evidence of RFR-induced genotoxicity. DNA damage was assessed in three brain regions (frontal cortex, hippocampus, and cerebellum), and in liver cells and blood leukocytes using the comet assay. Chromosomal damage was assessed in peripheral blood erythrocytes using the micronucleus assay. DNA damage was significantly increased in the frontal cortex of male mice (both modulations), peripheral leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). DNA damage was nominally elevated in several other tissues of RFR-exposed rats, although statistical significance was not achieved. No significant increases in micronucleated red blood cells were observed in rats or mice. These results suggest that exposure to RFR has the potential to induce measurable DNA damage under certain exposure conditions.

Paper presented at annual meeting of Environmental Mutagenesis and Genomics Society, Raleigh, North Carolina, September 9-13, 2017.

Aug 31, 2017

Microwave News reported that the National Toxicology Program (NTP) will release the "complete results" of its $25 million project on cell phone cancer risks early next year. The release of these data had been expected by the end of this year.

"The complete results from all the rat and mice studies will be available for peer review and public comment by early 2018," according to a new statement on the NTP Web site.

To date, the study has reported increased risk of cancer in the brain and heart of male rats from exposure to second generation (2G) cell phone radiation and increased risk of DNA damage in mice and rats of both sexes. For more information about the results of this study see the rest of this post.

This NTP project is our nation's only major research on the effects of cell phone radiation since the 1990's. The FDA recommended that the NTP conduct these toxicology and carcinogenicity studies in 1999. The FDA letter calling for this study can be downloaded from the NIEHS website.

The NTP is still studying the effects of 2G cellphone radiation which may soon be obsolete.

What about 3G, 4G, and 5G? Why must we rely on research from other nations to inform us about the health effects of this environmental toxin?

The Federal government should be held accountable for the lack of research in the U.S. on the health effects of wireless radiation since the 1990's.

Related Posts:

Government Failure to Address Wireless Radiation Risks
Industry-funded Scientists Undermine Cell Phone Radiation Science
An Exposé of the FCC: An Agency Captured by the Industries it Regulates
GAO 2012 Mobile Phone Report to the Congress
NTP: Not the First Govt. Study to Find Wireless Radiation Causes Cancer in Lab Rats
Storyline vs. Rest-of-the-story: Brain cancer incidence, cellphone use & trends data

April 4, 2017

According to ***Microwave News***, the National Toxicology Program (NTP) will not publish as a stand-alone paper its findings of increased DNA breaks among rats exposed to cell phone radiation. These data which have been reported at an international scientific conference will be incorporated in a technical report to be released in December. The report will provide a "final determination" about the level of evidence that cell phone radiation causes cancer.

The NTP's statement:

> "The genotoxicity paper was not accepted for stand-alone publication because the reviewers wanted additional detailed technical information on the methods used to expose the animals to radiofrequency radiation, as well as further placement of these findings in the context of the results of the two-year rodent studies. The complete results from all the rat and mice cancer studies remain in pathology review and the final determinations on the level of evidence for carcinogenic activity have not yet been made. For these reasons the decision was made to peer review and publish the genotoxicity data as part of the larger study in an NTP Technical Report."

For a summary of the evidence about DNA damage due to cell phone radiation see the posts below for June 10, 2016 and August 23, 2016.

September 7, 2016

The GREEN Gazette
Serving the Cariboo-Chilcotin, BC

HEALTH ISSUES | National Toxicology Program Report on Cancer Risk from Cellphone Radiation

The Green Gazette published an article today about the National Toxicology Program cell phone radiation study based upon my June 10 post which appears below.

http://www.thegreengazette.ca/health-issues-national-toxicology-program-report-on-cancer-risk-from-cellphone-radiation-2/

August 23, 2016

Presentation on NTP Study to NIEHS Board of Scientific Counselors

On June 15, Dr. Michael Wyde, the director of the cell phone radiation studies conducted by the National Toxicology Program (NTP), provided an overview of the studies to the Board of Scientific Counselors of the National Institute of Environmental Health Sciences (NIEHS). He summarized the research designs and the partial results for the toxicology and carcinogenicity studies.

A video of the presentation including the presentation slides and the question and answer session is available at https://youtu.be/TCRF71eMZ1Q.

According to Dr. Wyde, the FDA recommended that the NTP conduct toxicology and carcinogenicity studies of cell phone radiation in 1999. Completion of these studies is expected by some time in 2018.

The 1999 FDA letter calling for this study can be downloaded from the NIEHS website.

June 24, 2016

According to the National Institute of Environmental Health Sciences, the newly-released study on cellphone radiation and cancer in rats conducted by the National Toxicology Program (NTP) resulted in more than 1,000 news stories. Nearly 150 reporters participated in the telephone press conference held by the NTP on May 27

Unfortunately, much of the media coverage contained considerable bias, or "spin" intended to create doubt about the study's important findings regarding cancer risk from exposure to cellphone radiation Notable exceptions included news stories that appeared in the *Wall Street Journal* and *Mother Jones*.

June 10, 2016

NTP Toxicology & Carcinogenicity Cell Phone Radiofrequency Radiation Studies

Summary of Presentation at BioEM 2016 Meeting (Ghent, Belgium) by Michael Wyde, PhD, Director of NTP Studies of Cell Phone Radiation, NIEHS, June 8, 2016

Dr. Wyde explained the four reasons why the National Toxicology Program (NTP) decided to release partial study results at this time: 1) given widespread cellphone use, even a small increase in disease incidence could have major public health implications; 2) there is a high level of public and media interest in the study; 3) the tumor types observed in these studies are similar to those found in human studies of cellphone use; and 4) the results support the IARC classification of radiofrequency radiation as potentially cancer-causing in humans.

Dr. Wyde discussed the 5-day pilot studies conducted on young and aged mice and rats and on pregnant rats to determine the maximum intensity of cellphone radiation that could be employed in the subsequent studies without inducing any heating effect. He also described the 28-day pre-chronic toxicology studies and the 2-year toxicology and carcinogenicity studies.

For the pre-chronic studies, NTP selected SAR exposures of 0, 3, 6, and 9 watts/kilogram (W/kg) in rats and 0, 5, 10, and 15 W/kg in mice based on pilot study results. Pregnant rats were exposed prenatally and 28 days postnatal to 900 MHz cellphone radiation (GSM or CDMA). Five-week old mice were exposed to 1900 MHz cellphone radiation for 28 days.

Dr Wyde reported **statistically significant evidence of DNA damage from nonthermal exposure to cellphone radiation in mice as well as in rats:**

- male rats: frontal cortex, hippocampus, liver, blood
- male mice: frontal cortex
- female rats: frontal cortex
- female mice: liver, blood

The partial results of the carcinogenicity studies were also discussed. See my summary below.

The slides for this presentation are available at:
http://ntp.niehs.nih.gov/ntp/research/areas/cellphone/slides_bioem_wyde.pdf

June 13, 2016

Do Cellphones Cause Cancer? Probably, but It's Complicated
Dr. Chris Portier, Scientific American Blog, Jun 13, 2016

Setting the Record Straight on NTP Cell Phone Cancer Study
Dr. Ron Melnick Corrects 'Misinformation,' Rebuffed by the New York Times
Microwave News, Jun 10, 2016

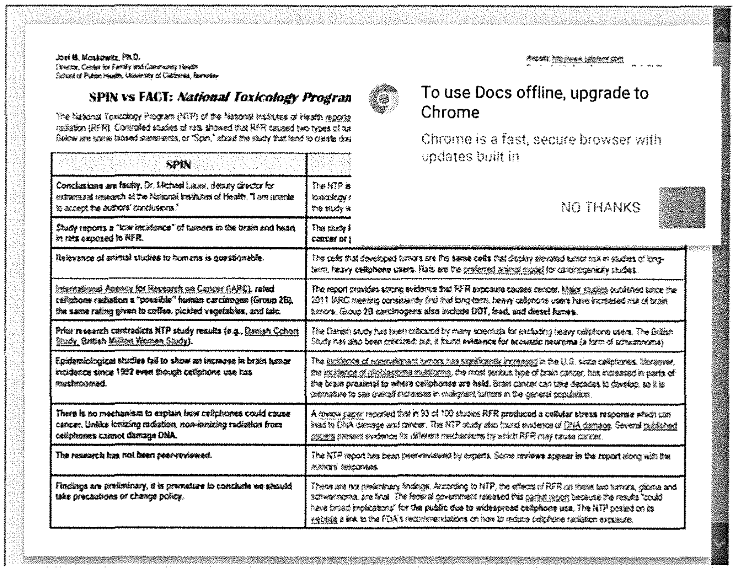
May 30, 2016

SPIN vs FACT: *National Toxicology Program* report on cancer risk from cellphone radiation

The National Toxicology Program (NTP) of the National Institutes of Health reported partial findings from their $25 million study of the cancer risk from cellphone radiofrequency radiation (RFR). Controlled studies of rats showed that RFR caused two types of tumors, glioma and schwannoma. The results "...could have broad implications for public health."

A fact sheet on the NTP study that summarizes some biased statements, or "Spin," about the study that tend to create doubt about data quality and implications, as well as "Facts" from decades of previous research is available at http://bit.ly/NTPspinfacts.

A German translation of this fact sheet is available at **diagnose:funk**. An Italian translation is available at **Amica Associazione**



Joel M. Moskowitz, Ph.D.
Director, Center for Family and Community Health
School of Public Health, University of California, Berkeley

Website: http://www.saferemr.com

SPIN vs FACT: *National Toxicology Progran*

The National Toxicology Program (NTP) of the National Institutes of Health reports
radiation (RFR). Controlled studies of rats showed that RFR caused two types of tu
Below are some biased statements, or "Spin," about the study that tend to create dou

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NO THANKS

SPIN	
Conclusions are faulty. Dr. Michael Lauer, deputy director for extramural research at the National Institutes of Health, "I am unable to accept the authors' conclusions."	The NTP is toxicology the study w
Study reports a "low incidence" of tumors in the brain and heart in rats exposed to RFR.	The study i **cancer or**
Relevance of animal studies to humans is questionable.	The cells that developed tumors are the **same cells** that display elevated tumor risk in studies of long-term, **heavy cellphone users.** Rats are the preferred animal model for carcinogenicity studies.
International Agency for Research on Cancer (IARC), rated cellphone radiation a "possible" human carcinogen (Group 2B), the same rating given to coffee, pickled vegetables, and talc.	The report provides strong evidence that RFR exposure causes cancer. Major studies published since the 2011 IARC meeting consistently find that long-term, heavy cellphone users have increased risk of brain tumors. Group 2B **carcinogens also include DDT, lead, and diesel fumes.**
Prior research contradicts NTP study results (e.g., Danish Cohort Study, British Million Women Study).	The Danish study has been criticized by many scientists for excluding heavy cellphone users. The British Study has also been criticized; but, it found **evidence for acoustic neuroma** (a form of schwannoma).
Epidemiological studies fail to show an increase in brain tumor incidence since 1992 even though cellphone use has mushroomed.	The incidence of nonmalignant tumors has significantly increased in the U.S. since cellphones. Moreover, the incidence of glioblastoma multiforme, the most serious type of brain cancer, has increased in parts of **the brain proximal to where cellphones are held.** Brain cancer can take decades to develop, so it is premature to see overall increases in malignant tumors in the general population.
There is no mechanism to explain how cellphones could cause cancer. Unlike ionizing radiation, non-ionizing radiation from cellphones cannot damage DNA.	A review paper reported that in 93 of 100 studies RFR produced a **cellular stress response** which can lead to DNA damage and cancer. The NTP study also found evidence of DNA damage. Several published papers present evidence for different mechanisms by which RFR may cause cancer.
The research has not been peer-reviewed.	The NTP report has been peer-reviewed by experts. Some **reviews appear in the report** along with the authors' responses.
Findings are preliminary, it is premature to conclude we should take precautions or change policy.	These are not preliminary findings. According to NTP, the effects of RFR on these two tumors, glioma and schwannoma, are final. The federal government released this partial report because the results "could have broad implications" for **the public due to widespread cellphone use.** The NTP posted on its website a link to the FDA's recommendations on how to reduce cellphone radiation exposure.

May 27, 2016 (updated June 1)

On May 26, the National Toxicology Program (NTP) of the National Institutes of Health issued the first in a series of reports that contains partial findings from their long-awaited, $25 million study of the cancer risk from cell phone radiation. This report summarizes the study of long-term exposure to cell phone radiation on rats. The report on mice will be issued at a later date.

According to the report:

> "Given the widespread global usage of mobile communications among users of all ages, even a very small increase in the incidence of disease resulting from exposure to RFR [radiofrequency radiation] could have broad implications for public health."

Overall, thirty of 540 (5.5%), **or one in 18 male rats exposed to cell phone radiation developed cancer.** In addition,16 pre-cancerous hyperplasias were diagnosed. Thus, 46 of 540, or **one in 12 male rats exposed to cell phone radiation developed cancer or pre-cancerous cells** as compared to none of the 90 unexposed male rats.

The two types of cancer examined in the exposed rats were glioma and schwannoma. Both types have been found in human studies of cell phone use.

In the group exposed to the **lowest intensity of cell phone radiation** (1.5 watts/kilogram or W/kg), 12 of 180, or **one in 15 male rats** developed cancer or pre-cancerous cells. In the **highest exposure** group (6 W/kg), 24 of 180, or **one in 8 male rats** developed cancer or pre-cancerous cells.

This latter finding has policy implications for the FCC's current cell phone regulations which allow cell phones to emit up to 1.6 W/kg at the head or near the body (partial body Specific Absorption Rate or SAR).

The NTP study is likely a **"game-changer"** as it proves that non-ionizing, radiofrequency radiation can cause cancer without heating tissue.

The results of the study reinforce the need for more stringent regulation of radiofrequency radiation and better disclosure of the health risks associated with wireless technologies -- two demands made by the **International EMF Scientist Appeal** -- a petition signed by 220 scientists who have published research on the effects of electromagnetic radiation.

Along with other recently published studies on the biologic and health effects of cell phone radiation, the International Agency for Research on Cancer of the World Health Organization should now have sufficient data to reclassify radiofrequency radiation from "possibly carcingogenic" to "probably carcinogenic in humans."

The risk of cancer increased with the intensity of the cell phone radiation whereas no cancer was found in the sham controls—rats kept in the same apparatus but without any exposure to cell phone radiation.

In contrast to the male rats, the incidence of cancer in **female rats** among those exposed to cell phone radiation was not statistically significant. Overall, sixteen of 540 (3.0%), or **one in 33 female rats exposed to cell phone radiation developed cancer or a pre-cancerous lesion** as compared to none of the 90 unexposed females. The NTP provided no explanation for the sex difference. The researchers pointed out that none of the human epidemiology studies has analysed the data by sex.

Why did cellphone radiation significantly increase cancer risk in male but not female rats? Perhaps, because glioma and heart schwannoma are less common in females. According to *Microwave News* (6/1/2016), the NTP report shows that among controls from past toxicology studies, males were ten times more likely to develop glioma than female rats (11 of 550 vs. 1 of 540). Also, males were twice as likely to develop heart schwannoma than female rats (9 of 669 vs. 4 of 699).

The researchers believe that the cancers found in this experimental study were caused by the exposure to cell phone radiation as none of the control animals developed cancer. The researchers controlled the temperature of the animals to prevent heating effects so the cancers were caused by a **non-thermal mechanism.**

One of two types of second-generation (2G) cell phone technology, GSM and CDMA, were employed in this study. The frequency of the signals was 900 MHz. The rats were exposed to cell phone radiation every 10 minutes followed by a 10-minute break for 18 hours, resulting in nine hours a day of exposure over a two-year period. Both forms of cell phone radiation were found to increase cancer risk in the male rats.

For each type of cell phone radiation, the study employed four groups of 90 rats -- a sham control group that was not exposed to radiation, and three exposed groups. The lowest exposure group had a SAR of 1.5 W/kg which is within the FCC's legal limit for partial body SAR exposure (e.g., at the head) from cell phones. The other exposure groups had SARs of 3 and 6 W/kg.

Glioma is a common type of brain cancer in humans. It affects about 25,000 people per year in the U.S. and is the most common cause of cancer death in adults 15-39 years of age. Several major studies have found increased risk of glioma in humans associated with long-term, heavy cell phone use.

In humans, schwannoma is a nonmalignant tumor that grows in Schwann cells that cover a nerve which connects to the brain. Numerous studies have found an increased risk of this rare tumor in heavy cell phone users. In the rat study, malignant schwannoma was found in Schwann cells in the heart.

The FDA requested in May, 1999 that the NIEHS research the effects of cell phone radiation on DNA in animal models. FDA called this a "high priority." Seventeen years later the NIEHS has released only partial results from a series of studies which should have taken only a few years to conduct.

For more information about the NTP study see http://bit.ly/govtfailure.

For references to the research that found increased risk of malignant and nonmalignant tumors among long-term cell phone users see http://bit.ly/WSJsaferemr.

The NTP report is available at http://bit.ly/NTPcell1.

Labels: Bucher, cancer, cell phone radiation, game-changer, glioma, mice, National Toxicology Program, NIEHS, NIH, NTP Study, rats, report, schwannoma, Wyde

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure f
Cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Monday, January 1, 2018

Electromagnetic Radiation Safety: 2017 Year in Review

EMR Safety addresses scientific and policy developments concerning the health risks from exposure to electromagnetic radiation (EMR). Since 2013, it has had over 1.3 million page views by visitors from more than 200 countries which attests to the worldwide concern about the impact of wireless radiation on our health.

During the past year, over half of visitors were from outside the United States with Canada, the United Kingdom, India, Australia, Israel, Germany, Greece, Italy and Sweden represented the most. About two-thirds of visitors were 25-54 years of age and 60% were male.

This site provides a curated collection of links to articles on cell phones and cordless phones, cell towers, Wi-Fi, Smart Meters and other wireless devices. I summarize the peer-reviewed research on health risks associated with wireless radiation including cancer risk, reproductive harm and neurological disorders; and I expose the manufacturing of doubt about these risks by industry-linked scientists.

The following links were the most popular wireless radiation stories in 2017 including related posts and wireless product stories.

Most popular wireless radiation stories in 2017

Cell Phone Safety Guidance from the California Public Health Department
- California's Cell Phone Safety Guidance: Media Coverage

Cell Phone and Wireless Technology Safety Tips
- Wireless Radiation TV News

Scientists and Doctors Demand Moratorium on 5G
- International Scientist Appeal on Electromagnetic Radiation Safety

5G Wireless Technology: Is 5G Harmful to Our Health?
- 5G Wireless Technology: Millimeter Wave Health Effects
- 5G Wireless Technology: Cutting Through the Hype
- 5G Wireless Technology: Major newspaper editorials oppose "small cell" antenna bills
- Cell Tower Health Effects
- Electromagnetic Hypersensitivity (EHS)

Hybrid& Electric Cars: Electromagnetic Radiation Risks

Brain Tumor Rates Are Rising in the US: The Role of Cellphone & Cordless Phone Use
- Storyline vs. Rest-of-the-story: Brain cancer incidence, cellphone use & trends data

Cell phone and cordless phone use causes brain cancer: New review
- Long-Term Cell Phone Use Increases Brain Tumor Risk

National Toxicology Program (NTP) Finds Cell Phone Radiation Causes Cancer
- NTP: Not the First Govt. Study to Find Wireless Radiation Can Cause Cancer in Lab Rats

Recent Research on Wi-Fi Effects
- Wi-Fi in Schools & Other Public Places

Berkeley Cell Phone "Right to Know" Ordinance
- Berkeley Cell Phone "Right to Know" Ordinance: Media Coverage

Research on Smart Phone and Internet Addiction
- Has the Smart Phone Replaced the Cigarette?

Most popular wireless product stories in 2017

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Electromagnetic Radiation Safety

Archive

Samsung Galaxy S7 and S7 Edge Specific Absorption Rates (SAR)

Samsung Galaxy S8 and S8 Plus Specific Absorption Rates (SAR)

- Do iPhones emit more radiation than Samsung Galaxy Phones?

iPhone 7 Models: Specific Absorption Rates (SAR) or RF Exposure

iPhone 8 Models: Specific Absorption Rates (SAR) or RF Exposure

iPhone X Models: Specific Absorption Rates (SAR) or RF Exposure

AirPods: Are Apple's New Wireless Earbuds Safe? (Blood-brain barrier effects)

New Apple Watch Reignites Concerns over Cell Phone Radiation

Labels: 2017, 5G, cell phone, Galaxy, iPhone, NTP, SAR, wireless radiation

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure f
cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Friday, October 6, 2017

Key Cell Phone Radiation Research Studies

Note: This is not intended to be a comprehensive list. I have focused on more recent papers and tried to be parsimonious. I will update this list periodically.

For additional research studies, see my post, "Should Cellphones Have Warning Labels? (Wall Street Journal)."

National Toxicology Program (2016) *Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley SD Rats (Whole Body Exposure).* http://biorxiv.org/content/early/2016/05/23/055699 (see http://bit.ly/NTPsaferemr)

Tumor risk review papers

Myung et al (2009) Mobile phone use and risk of tumors: a meta-analysis. http://1.usa.gov/12wBOmd
Khurana et al (2009) Cell phones and brain tumors: a review including long-term epidemiologic data. http://1.usa.gov/1jel7s0
Levis et al (2011) Mobile phones and head tumours: the discrepancies in cause-effect relationships in the epi studies-how do they arise. http://1.usa.gov/1gzK8vl
Levis et al (2012) Mobile phones and head tumours: a critical analysis of case-control epi studies. http://bit.ly/1nA9eTM
WHO (2013) IARC monographs on the evaluation of carcinogenic risks to humans. Volume 102: Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. http://bit.ly/10olE3o
Morgan et al (2015) Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A) (Review). http://1.usa.gov/1EqL1DF
Wang Y, Guo X (2016) Meta-analysis of association between mobile phone use and glioma risk. http://bit.ly/2o1dVcn
Bortkiewicz et al (2017) Mobile phone use and risk of intracranial tumors and salivary gland tumors - A meta-analysis. http://bit.ly/2nVJC5d
Prasad et al (2017) Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes. http://bit.ly/cellphonebraintumor
Carlberg, Hardell (2017) Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. http://bit.ly/2p1ovBU

Also see Long-Term Cell Phone Use Increases Brain Tumor Risk

Tumor risk studies

Interphone Study Group (2010) Brain tumour risk in relation to mobile phone use: results of the Interphone international case-control study. http://1.usa.gov/lBm2nJ
Interphone Study Group (2011) Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. http://1.usa.gov/18CRSNA
Aydin et al (2011) Mobile phone use & brain tumors in children & adolescents: a multi-center case-control study. http://1.usa.gov/1baLADg
Hardell et al (2013) Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. http://1.usa.gov/1c7WF4T
Hardell et al (2013) Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. http://1.usa.gov/1iu2ORM
Coureau et al (2014) Mobile phone use and brain tumours in the CERENAT case-control study. http://bit.ly/1DWgzRi
Grell et al (2016) The intracranial distribution of gliomas in relation to exposure from mobile phones: Analyses from the INTERPHONE Study. http://bit.ly/2emIZjz

Acoustic neuroma risk and cell phone use studies

Also see: http://www.saferemr.com/2016/05/should-cellphones-have-warning-labels_23.html

Breast cancer

West et al (2013) Multifocal breast cancer in young women with prolonged contact between their breasts and their cellular phones. http://1.usa.gov/1yFRFBH

Brain tumor incidence trends

Inskip et al (2010) Brain cancer incidence trends in relation to cellular telephone use in the United States. http://1.usa.gov/1DXyCGR
Zada et al (2012) Incidence trends in the anatomic location of primary malignant brain tumors in the United States: 1992-2006. http://1.usa.gov/1iRnRPJ
Hardell & Carlberg (2015) Increasing rates of brain tumours in the Swedish National Inpatient Register & the Causes of Death Register. http://bit.ly/1aDHJm
Devocht (2016) Inferring the 1985–2014 impact of mobile phone use on selected brain cancer subtypes using Bayesian structural time series and synthetic controls. http://bit.ly/2jJlbZu corrigendum (2017): http://bit.ly/2Cuq2nU
Hardell & Carlberg (2017) Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. http://bit.ly/H-C2017

Also see: http://www.saferemr.com/2016/05/brain-tumor-rates-are-rising-in-us-role.html.

Mechanisms

Ruediger (2009) Genotoxic effects of RF EMF. http://1.usa.gov/1gzLuX3
Behari (2010) Biological responses of mobile phone frequency exposure. http://1.usa.gov/1jeogrO
Juutilainen et al (2011) Review of possible modulation-dependent biological effects of radiofrequency fields. http://1.usa.gov/1eQUXJ3

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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

Volkow et al (2011) Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. http://1.usa.gov/lHmW2W
Pall (2013) EMFs act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. http://1.usa.gov/VulzLm
Dasdag & Akdag (2015) The link between RFs emitted from wireless technologies & oxidative stress. http://1.usa.gov/1X9GIT6
Yakymenko et al (2016) Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. http://bit.ly/2qCGM4F
Barnes & Greenenbaum (2016) Some effects of weak magnetic fields on biological systems: RF fields can change radical concentrations and cancer cell growth rates. http://bit.ly/1WvQGiY
Nikiforov et al (2016) On a possible mechanism of the effect of microwave radiation on biological macromolecules (Russian language). http://bit.ly/2uR71r4
Tamrin et al (2016) Electromagnetic fields and stem cell fate: When physics meets biology. http://bit.ly/2b6Ht3y
Terzi et al (2016) The role of electromagnetic fields in neurological disorders. http://1.usa.gov/1SVOa2g
Havas (2017) When theory and observation collide: Can non-ionizing radiation cause cancer? http://bit.ly/2DssMS2

Reproductive Health Effects

LaVignera et al (2011) Effects of the exposure to mobile phones on male reproduction: a review of the literature. http://1.usa.gov/1eOXwuv
Aldad et al (2012) Fetal radiofrequency radiation exposure from 800-1900 Mhz-rated cellular telephones affects neurodevelopment and behavior in mice. http://1.usa.gov/18cGEwK
Divan et al (2012) Cell phone use and behavioural problems in young children. http://1.usa.gov/1iu5qPn
Adams et al (2014) Effect of mobile telephones on sperm quality: A systematic review and meta-analysis. http://bit.ly/1pUnmDq
Houston et al (2016) The effects of radiofrequency electromagnetic radiation on sperm function. http://bit.ly/2cJJ2pE

Also see: http://www.saferemr.com/2015/09/effect-of-mobile-phones-on-sperm.html and http://www.saferemr.com/2014/06/joint-statement-on-pregnancy-and.html.

Electromagnetic Hypersensitivity

See: http://www.saferemr.com/2014/10/electromagnetic-hypersensitivity_30.html

Exposure

Kelsh et al (2010) Measured radiofrequency exposure during various mobile-phone use scenarios. http://1.usa.gov/1eQXinm
Gandhi et al (2012) Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. http://1.usa.gov/1cVJBRO

Blood-Brain Barrier Studies

See: http://www.saferemr.com/2016/09/airpods-are-apples-new-wireless-earbuds.html

Other

Alster, N (2015) *Captured agency: How the FCC is dominated by the industries it presumably regulates.* Harvard University. http://bit.ly/FCCcaptured

Consumer Reports (2015). "Does cell-phone radiation cause cancer?" http://bit.ly/CRoncellphoneradiation

Fragopoulou A, Grigoriev Y, Johansson O, Margaritis LH, Morgan L, Richter E, Sage C. Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales. Rev Environ Health.2010;25(4):307-17. http://bit.ly/2tWiXHP

Huss A, Egger M, Hug K, Huwiler-Müntener K, Röösli M. Source of funding and results of studies of health effects of mobile phone use: systematic review of experimental studies. Environ Health Perspect. 2007 Jan;115(1):1-4. http://bit.ly/2wBEmYp

International EMF Scientist Appeal (2015) https://emfscientist.org/

International Appeal: Scientists call for protection from non-ionizing electromagnetic field exposure. *European J Oncology*. 20 (3/4). 2015. http://bit.ly/EMFappealEurJ

Kostoff RN, Lau CGY. Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature. In C.D. Geddes (ed.), Microwave Effects on DNA and Proteins. Switzerland: Springer, pp. 97-158.DOI 10.1007/978-3-319-50289-2. 2017. Open access. http://b.gatech.edu/2uyMAz0

G+

Labels: cell phone, exposure, mechanisms, references, reproductive health effects, research studies, review, tumor risk, wireless

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Wednesday, September 13, 2017

Cell Tower Health Effects

Federal regulations protect the public only from the thermal (i.e., heating) risk due to short-term exposure to high intensity, cell tower radiation. The Federal regulations ignore the hundreds of studies that find harmful bio-effects from long-term exposure to non-thermal levels of cell phone radiation.

The Telecommunications Act of 1996 does not allow communities to stop the siting of cell towers for health reasons. Nevertheless, landlords may be liable for any harm caused by cell phone radiation emitted by towers situated on their property.

Localities need to organize and change the Federal law to protect public health and wildlife from exposure to microwave radiation emitted by mobile phone base stations.

Following are some resources regarding the health effects of exposure to cell tower radiation. I will occasionally update this page.

Related posts

Major newspaper editorials oppose 5G "small cell antennas

Is 5G Cellular Technology Harmful to Our Health?

Electromagnetic Hypersensitivity

Wireless Radiation TV News

Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations

Zothansiama, Zosangzuali M, Lalramdinpuii M, Jagetia GC. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med. 2017 Aug 4:1-11. doi: 10.1080/15368378.2017.1350584.

Abstract

Radiofrequency radiations (RFRs) emitted by mobile phone base stations have raised concerns on its adverse impact on humans residing in the vicinity of mobile phone base stations. Therefore, the present study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes (HPBLs) of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.
The study groups matched for various demographic data including age, gender, dietary pattern, smoking habit, alcohol consumption, duration of mobile phone use and average daily mobile phone use.

The RF power density of the exposed individuals was significantly higher ($p < 0.0001$) when compared to the control group. The HPBLs were cultured and the DNA damage was assessed by cytokinesis blocked micronucleus (MN) assay in the binucleate lymphocytes. The analyses of data from the exposed group ($n = 40$), residing within a perimeter of 80 meters of mobile base stations, showed significantly ($p < 0.0001$) higher frequency of micronuclei (MN) when compared to the control group, residing 300 meters away from the mobile base station/s.

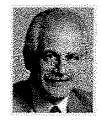
The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione (GSH) concentration ($p < 0.01$), activities of catalase (CAT) ($p < 0.001$) and superoxide dismutase (SOD) ($p < 0.001$) and rise in lipid peroxidation (LOO) when compared to controls. Multiple linear regression analyses revealed a significant association among reduced GSH concentration ($p < 0.05$), CAT ($p < 0.001$) and SOD ($p < 0.001$) activities and elevated MN frequency ($p < 0.001$) and LOO ($p < 0.001$) with increasing RF power density.

https://www.ncbi.nlm.nih.gov/pubmed/28777669

My note

All of the recorded RFR power density values in this study were well below the Federal Communication Commission's maximum permissible exposure limits in the U.S. for the general population. These limits are are 6,000 mW/m^2 [milliwatts per square meter] for 900 MHz and 10,000 mW/m^2 for 1800 MHz radiofrequency radiation. In contrast, the highest recorded value in this study was 7.52 mW/m^2 of RFR. The "exposed individuals" who resided within 80 meters of a cell antenna received an average of 5.00 mW/m^2 of RFR in their bedrooms.

Excerpts



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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

RFR may change the fidelity of DNA as the increased incidence of cancer has been reported among those residing near mobile phone base stations (Abdel-Rassonl et al., 2007; Bortkiewicz et al., 2004; Cherry, 2000; Eger et al., 2004; Hardell et al., 1999; Hutter et al., 2006; Wolf and Wolf, 2004). RFR emitted frommobile base stations is also reported to increase the DNA strand breaks in lymphocytes of mobile phone users and individuals residing in the vicinity of a mobile base station/s (Gandhi and Anita, 2005; Gandhi et al., 2014). Exposure of human fibroblasts and rat granulosa cells to RFR (1800 MHz, SAR 1.2 or 2 W/kg) has been reported to induce DNA single- and double-strands breaks (Diem et al., 2005). Irreversible DNA damage was also reported in cultured human lens epithelial cells exposed to microwave generated by mobile phones (Sun et al., 2006). The adverse health effects of RFR are still debatable as many studies indicated above have found a positive correlation between the DNA damage and RFR exposure; however, several studies reported no significant effect of RFR on DNA strand breaks and micronuclei formation in different study systems (Li et al., 2001; Tice et al., 2002; McNamee et al., 2003;Maes et al., 2006). The potential genotoxicity of RFR emitted by mobile phone base stations can be determined by micronucleus (MN) assay, which is an effective tool to evaluate the genotoxic or clastogenic effects of physical and chemical agents. This technique has also been used to quantify the frequencies of radiation-induced MN in human peripheral blood lymphocytes (HPBLs) (Fenech and Morley, 1985; Jagetia and Venkatesha, 2005; Prosser et al., 1988; Yildirim et al., 2010).

Six mobile phone base stations, operating in the frequency range of 900 MHz (N = 2) and1800MHz (N = 4), erected in the thickly populated areas of Aizawl city were selected for the present study… The power output of all the base stations is 20 W, with their primary beam emitting radiation at an angle of 20°. Power density measurements (using HF-60105V4, Germany) were carried out in the bedroom of each participant where they spent most of the time and hence have the longest constant level of electromagnetic field exposure. Power density measurement was carried out three times (morning, midday and evening), and the average was calculated for each residence around each base station. The main purpose of the measurement of power density was to ensure that RFR emission from each site did not exceed the safe public limits and to determine any difference in power density between selected households that were close to (within 80 m) and far (>300 m) from the mobile phone base stations. The safety limits for public exposure from mobile phone base stations are 0.45 W/m^2 for 900 MHz and 0.92 W/m^2 for 1800 MHz frequency as per Department of Telecommunications, Ministry of Communications, Government of India, New Delhi guidelines (DoT, 2012).

… some residences are located horizontally with the top of the towers from which RFR are emitted, making it possible to get an exposure at a short distance of 1–20 m, despite being erected on the rooftop or in the ground. A minimum of two individuals were sampled from each household and at least five individuals were sampled around each mobile base station. Individuals sampled around each base station were matched for their age and gender (Table 1). The exposed group consisted of 40 healthy individuals who fulfilled the inclusion criteria of being above 18 years of age and residing in the vicinity of mobile phone base stations (within 80 m radius). The control group comprised of 40 healthy individuals matched for age and gender who had been living at least 300 m away from any mobile phone base stations…. Sampling was also done only from those residences who did not use microwave oven for cooking, Wifi devices and any other major source of electromagnetic field as they are known to cause adverse effects (Atasoy et al., 2013; Avendaño et al., 2012).

The groups matched for most of the demographic data such as age, gender, dietary pattern, smoking habit, alcohol consumption, mobile phone usage, duration of mobile phone use and average daily mobile phone use (Table 2). A highly significant variation ($p < 0.0001$) was observed for the distance of household from the base station (40.10 ± 3.02 vs. 403.17 ± 7.98 in m) between exposed and control groups.

The RF power density of the exposed group (2.80–7.52 mW/m^2; average 5.002 ± 0.182 mW/ m^2) was significantly higher ($p < 0.0001$) when compared to the control group (0.014–0.065 mW/m^2; average 0.035 ± 0.002 mW/m^2). The highest power density was recorded at a distance of 1–20 m (6.44 ± 0.31 mW/m^2), which is significantly higher ($p < 0.0001$) than those at a distance of 21–40 m (4.79 ± 0.33), 41–60 m (4.48 ± 0.22) and 61–80 m (4.61 ± 0.10).

The highest measured power density was 7.52mW/m^2. Most of the measured values close to base stations (Table 1) are higher than that of the safe limits recommended by Bioinitiative Report 2012 (0.5mW/m^2), Salzburg resolution 2000 (1 mW/m^2) and EU (STOA) 2001 (0.1 mW/m^2). However, all the recorded values were well below the current ICNIRP safe level (4700 mW/m^2) and the current Indian Standard (450 mW/m^2).

The exact mechanism of action of RFR in micronuclei induction and reduced antioxidant status is not apparent. The possible putative mechanism of generation of DNA damage may be the production of endogenous free radicals due to continuous exposure. RFR has been reported to produce different free radicals earlier (Avci et al., 2009; Burlaka et al., 2013; Barcal et al., 2014; Kazemi et al., 2015). Cells possess a number of compensatory mechanisms to deal with ROS and its effects. Among these are the induction of antioxidant proteins such as GSH, SOD and CAT. Enzymatic antioxidant systems function by direct or sequential removal of ROS, thereby terminating their activities. An imbalance between the oxidative forces and antioxidant defense systems causes oxidative injury, which has been implicated in various diseases, such as cancer, neurological disorders, atherosclerosis, diabetes, liver cirrhosis, asthma, hypertension and ischemia (Andreadis et al., 2003; Comhair et al., 2005; Dhalla et al., 2000; Finkel and Holbrook, 2000; Kasparova et al., 2005; Sayre et al., 2001; Sohal et al., 2002). Because of the significant decrease in endogenous antioxidants and increased LOO among the exposed group, the extra burden of free radicals is unlikely to get neutralized, and these surplus ROS may react with important cellular macromolecules including DNA forming either DNA adducts or stand breaks, which may be later expressed as micronuclei once the cell decides to divide. The decline in the antioxidant status may be also due to the suppressed activity of Nrf2 transcription factor which is involved in maintaining the antioxidant status in the cells.

The present study has reported that [radiofrequency radiation] increased the frequency of [micronuclei] and [lipid peroxidation] and reduced [glutathione] contents, [catalase] and [superoxide dismutase] activities in the plasma of the exposed individuals. The induction of [micronuclei] may be due to the increase in free-radical production. The present study demonstrated that staying near the mobile base stations and continuous use of mobile phones damage the DNA, and it may have an adverse effect in the long run. The persistence of DNA unrepaired damage leads to genomic instability which may lead to several health disorders including the induction of cancer.

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Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

Levitt BB, Lai H. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environmental Reviews.18: 369–395 (2010) doi:10.1139 /A10-018.

Open Access Paper:
http://www.nrcresearchpress.com/doi/pdfplus/10.1139/A10-018?src=recsys

Abstract

The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and

landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed.

Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations.

The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted.

Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.

Excerpts

[Note: As of July 9, 2017, www.antennasearch.com, an industry website, reports 646,000 towers and 1.89 million cell antennas in the U.S.]

In lieu of building new cell towers, some municipalities are licensing public utility poles throughout urban areas for Wi-Fi antennas that allow wireless Internet access. These systems can require hundreds of antennas in close proximity to the population with some exposures at a lateral height where second- and third-story windows face antennas. Most of these systems are categorically excluded from regulation by the U.S. Federal Communications Commission (FCC) or oversight by government agencies because they operate below a certain power density threshold. However, power density is not the only factor determining biological effects from radiofrequency radiation (RFR).

An aesthetic emphasis is often the only perceived control of a municipality, particularly in countries like America where there is an overriding federal preemption that precludes taking the "environmental effects" of RFR into consideration in cell tower siting as stipulated in Section 704 of *The Telecommunications Act of 1996* (USFCC 1996). Citizen resistance, however, is most often based on health concerns regarding the safety of RFR exposures to those who live near the infrastructure. Many citizens, especially those who claim to be hypersensitive to electromagnetic fields, state they would rather know where the antennas are and that hiding them greatly complicates society's ability to monitor for safety.

Industry representatives try to reassure communities that facilities are many orders of magnitude below what is allowed for exposure by standards-setting boards and studies bear that out (Cooper et al. 2006; Henderson and Bangay 2006; Bornkessel et al. 2007). These include standards by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) used throughout Europe, Canada, and elsewhere (ICNIRP 1998). The standards currently adopted by the U.S. FCC, which uses a two-tiered system of recommendations put out by the National Council on Radiation Protection (NCRP) for civilian exposures (referred to as uncontrolled environments), and the International Electricians and Electronics Engineers (IEEE) for professional exposures (referred to as controlled environments) (U.S. FCC 1997). The U.S. may eventually adopt standards closer to ICNIRP. The current U.S. standards are more protective than ICNIRP's in some frequency ranges so any harmonization toward the ICNIRP standards will make the U.S. limits more lenient.

All of the standards currently in place are based on RFRs ability to heat tissue, called thermal effects. A longstanding criticism, going back to the 1950s (Levitt 1995), is that such acute heating effects do not take potentially more subtle non-thermal effects into consideration. And based on the number of citizens who have tried to stop cell towers from being installed in their neighborhoods, laypeople in many countries do not find adherence to existing standards valid in addressing health concerns. Therefore, infrastructure siting does not have the confidence of the public (Levitt 1998).

The intensity of RFR decreases rapidly with the distance from the emitting source; therefore, exposure to RFR from transmission towers is often of low intensity depending on one's proximity. But intensity is not the only factor. Living near a facility will involve long-duration exposures, sometimes for years, at many hours per day. People working at home or the infirm can experience low-level 24 h exposures. Nighttimes alone will create 8 hour continuous exposures. The current standards for both ICNIRP, IEEE and the NCRP (adopted by the U.S. FCC) are for whole-body exposures averaged over a short duration (minutes) and are based on results from short-term exposure studies, not for long-term, low-level exposures such as those experienced by people living or working near transmitting facilities. For such populations, these can be involuntary exposures, unlike cell phones where user choice is involved.

The U.S. FCC has issued guidelines for both power density and SARs. For power density, the U.S. guidelines are between 0.2–1.0 mW/cm^2....

At 100–200 ft (about 30–60 meters) from a cell phone base station, a person can be exposed to a power density of 0.001 mW/cm^2 (i.e., 1.0 μW/cm^2)....

For the purposes of this paper, we will define low-intensity exposure to RFR of power density of 0.001 mW/cm^2

Many biological effects have been documented at very low intensities comparable to what the population experiences within 200 to 500 ft (~60–150 m) of a cell tower, including effects that occurred in studies of cell cultures and animals after exposures to low-intensity RFR. Effects reported include: genetic, growth, and reproductive; increases in permeability of the blood–brain barrier; behavioral; molecular, cellular, and metabolic; and increases in cancer risk....

Ten years ago, there were only about a dozen studies reporting such low-intensity effects; currently, there are more than 60. This body of work cannot be ignored. These are important findings with implications for anyone living or working near a transmitting facility. However, again, most of the studies in the list are on short-term (minutes to hours) exposure to low-intensity RFR. Long-term exposure studies are sparse. In addition, we do not know if all of these reported effects occur in humans exposed to low-intensity RFR, or whether the reported effects are health hazards. Biological effects do not automatically mean adverse health effects, plus many biological effects are reversible. However, it is clear that low-intensity RFR is not biologically inert. Clearly, more needs to be learned before a presumption of safety can continue to be made regarding placement of antenna arrays near the population, as is the case today.

... The previously mentioned studies show that RFR can produce effects at much lower intensities after test animals are repeatedly exposed. This may have implications for people exposed to RFR from transmission towers for long periods of time.

... The conclusion from this body of work is that effects of long-term exposure can be quite different from those of short-term exposure.

Since most studies with RFR are short-term exposure studies, it is not valid to use their results to set guidelines for long-term exposures, such as in populations living or working near cell phone base stations.

Numerous biological effects do occur after short-term exposures to low-intensity RFR but potential hazardous health effects from such exposures on humans are still not well established, despite increasing evidence as demonstrated throughout this paper. Unfortunately, not enough is known about biological effects from long-term exposures, especially as the effects of long-term exposure can be quite different from those of short-term exposure. It is the long-term, low-intensity exposures that are most common today and increasing significantly from myriad wireless products and services.

People are reporting symptoms near cell towers and in proximity to other RFR-generating sources including consumer products such as wireless computer routers and Wi-Fi systems that appear to be classic "microwave sickness syndrome," also known as "radiofrequency radiation sickness." First identified in the 1950s by Soviet medical researchers, symptoms included headache, fatigue, ocular dysfunction, dizziness, and sleep disorders. In Soviet medicine, clinical manifestations include dermographism, tumors, blood changes, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment, among others. The Soviet researchers noted that the syndrome is reversible in early stages but is considered lethal over time (Tolgskaya et al. 1973).

The present U.S. guidelines for RFR exposure are not up to date. The most recent IEEE and NCRP guidelines used by the U.S. FCC have not taken many pertinent recent studies into consideration because, they argue, the results of many of those studies have not been replicated and thus are not valid for standards setting. That is a specious argument. It implies that someone tried to replicate certain works but failed to do so, indicating the studies in question are unreliable. However, in most cases, no one has tried to exactly replicate the works at all.... In addition, effects of long-term exposure, modulation, and other propagation characteristics are not considered. Therefore, the current guidelines are questionable in protecting the public from possible harmful effects of RFR exposure and the U.S. FCC should take steps to update their regulations by taking all recent research into consideration without waiting for replication that may never come because of the scarcity of research funding. The ICNIRP standards are more lenient in key exposures to the population than current U.S. FCC regulations. The U.S. standards should not be "harmonized" toward more lenient allowances. The ICNIRP should become more protective instead. All standards should be biologically based, not dosimetry based as is the case today.

Exposure of the general population to RFR from wireless communication devices and transmission towers should be kept to a minimum and should follow the "As Low As Reasonably Achievable" (ALARA) principle. Some scientists, organizations, and local governments recommend very low exposure levels — so low, in fact, that many wireless industries claim they cannot function without many more antennas in a given area. However, a denser infrastructure may be impossible to attain because of citizen unwillingness to live in proximity to so many antennas. In general, the lowest regulatory standards currently in place aim to accomplish a maximum exposure of 0.02 V/m, equal to a power density of 0.0001 $\mu W/cm^2$, which is in line with Salzburg, Austria's indoor exposure value for GSM cell base stations. Other precautionary target levels aim for an outdoor cumulative exposure of 0.1 $\mu W/cm^2$ for pulsed RF exposures where they affect the general population and an indoor exposure as low as 0.01 $\mu W/cm^2$ (Sage and Carpenter 2009). In 2007, *The BioInitiative Report, A rationale for a biologically based public exposure standard for electromagnetic fields (ELF and RF)*, also made this recommendation, based on the precautionary principle (Bioinitiative Report 2007).

Citizens and municipalities often ask for firm setbacks from towers to guarantee safety. There are many variables involved with safer tower siting — such as how many providers are co-located, at what frequencies they operate, the tower's height, surrounding topographical characteristics, the presence of metal objects, and others. Hard and fast setbacks are difficult to recommend in all circumstances. Deployment of base stations should be kept as efficient as possible to avoid exposure of the public to unnecessary high levels of RFR. As a general guideline, cell base stations should not be located less than 1500 ft (~500 m) from the population, and at a height of about 150 ft (~50 m). Several of the papers previously cited indicate that symptoms lessen at that distance, despite the many variables involved. However, with new technologies now being added to cell towers such as Wi-Max networks, which add significantly more power density to the environment, setback recommendations can be a very unpredictable reassurance at best. New technology should be developed to reduce the energy required for effective wireless communication.

In addition, regular RFR monitoring of base stations should be considered....

Table 1. List of studies reporting biological effects at low intensities of radiofrequency radiation (RFR).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Balmori (2010) (in vivo) (eggs and tadpoles of frog)	88.5–1873.6 MHz	Cell phone base station emission	2 months		3.25	Retarded development
Belyaev et al. (2005) (in vitro)	915 MHz	GSM	24, 48 h	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz	GSM, UMTS	24, 72 h	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz	AM at 16 Hz		0.0014		Calcium in forebrain of chickens
Boscol et al. (2001) (in vivo) (human whole body)	500 KHz–3 GHz	TV broadcast			0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz	CW (CW– no effect observed) AM at 50 Hz	14 days, 5, 10, 20 min per day		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz	GSM	1 h/day, 3 days	0.07		A slight decrease in cell proliferation

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

						when human immune cells were stimulated with mitogen and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane
Chiang et al. (1989) (in vivo) (human whole body)	Lived and worked close to AM radio and radar installations for more than 1 year				10	People lived and worked near AM radio antennas and radar installations showed deficits in psychological and short-term memory tests
de Pomerai et al. (2003) (in vitro)	1 GHz		24, 48 h	0.015		Protein damages
D'Inzeo et al. (1988) (in vitro)	10.75 GHz	CW	30–120 s	0.008		Operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions
Dutta et al. (1984) (in vitro)	915 MHz	Sinusoidal AM at 16 Hz	30 min	0.05		Increase in calcium efflux in brain cancer cells
Dutta et al. (1989) (in vitro)	147 MHz	Sinusoidal AM at 16 Hz	30 min	0.005		Increase in calcium efflux in brain cancer cells
Fesenko et al. (1999) (in vivo) (mouse- wavelength in mm range)	From 8.15–18 GHz		5 h to 7 days direction of response depended on exposure duration		1	Change in immunological functions
Forgacs et al. (2006) (in vivo) (mouse whole body)	1800 MHz	GSM, 217 Hz pulses, 576 μs pulse width	2 h/day, 10 days	0.018		Increase in serum testosterone
Guler et al. (2010) (in vivo) (rabbit whole body)	1800 MHz	AM at 217 Hz	15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars				10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references
Ivaschuk et al. (1997) (in vitro)	836.55 MHz	TDMA	20 min	0.026		A gene related to cancer
Jech et al. (2001) (in vivo) (human partial body exposure-narcoleptic patients)	900 MHz	GSM— 217 Hz pulses, 577 μs pulse width	45 min	0.06		Improved cognitive functions
Kesari and Behari (2009) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2010) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz	50 Hz modulation	2 h/day, 35 days	0.11		DNA double strand breaks in brain cells
Kwee et al. (2001) (in vitro)	960 MHz	GSM	20 min	0.0021		Increased stress protein in human epithelial amnion cells
Lebedeva et al. (2000) (in vivo) (human partial body)	902.4 MHz	GSM	20 min		60	Brain wave activation
Lerchl et al. (2008) (in vivo) (hamster whole body)	383 MHz 900 and 1800 MHz	TETRA GSM	24 h/day, 60 days	0.08		Metabolic changes
Magras and Xenos (1997) (in vivo) (mouse whole body)	"Antenna park"	TV and FM-radio	Exposure over several generations		0.168	Decrease in reproductive function
Mann et al. (1998) (in vivo) (human whole body)	900 MHz	GSM pulse-modulated at 217 Hz, 577 μs width	8 h		20	A transient increase in blood cortisol
Marinelli et al. (2004) (in vitro)	900 MHz	CW	2–48 h	0.0035		Cell's self-defense responses triggered by DNA damage
Marková et al. (2005) (in vitro)	915 and 905 MHz	GSM	1 h	0.037		Chromatin conformation in human white blood cells
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz 3000 MHz	CW (no effect observed) Pulse-modulated 2 μs pulses at 400 Hz	Single (0.5–12hr) or repeated (15–60 days, 7–12 h/day) exposure, CW–no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin
Nittby et al. (2008) (in vivo) (rat whole body)	900 MHz,	GSM	2 h/week, 55 weeks	0.0006		Reduced memory functions
Novoselova et al. (1999) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time – 16 ms reverse, 5 h		1	Functions of the immune system
Novoselova et al. (2004) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time16 ms reverse, 1.5 h/day, 30 days		1	Decreased tumor growth rate and enhanced survival
Panagopoulos et al. (2010) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		1–10	Reproductive capacity and induced cell death
Panagopoulos and Margaritis (2010a) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		10	'Window' effect of GSM radiation on reproductive capacity and cell death
Panagopoulos and Margaritis (2010b) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	1–21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure
Pavicic and Trosic (2008) (in vitro)	864 and 935 MHz	CW	1–3 h	0.08		Growth affected in Chinese hamster V79 cells
Pérez-Castejón et al. (2009) (in vitro)	9.6 GHz	90% AM	24 h	0.0004		Increased proliferation rate in human astrocytoma cancer cells
Persson et al. (1997) (in vivo) (mouse whole body)	915 MHz	CW and pulse-modulated (217 Hz, 0.57 ms; 50 Hz, 6.6 ms)	2–960 min; CW more potent	0.0004		Increase in permeability of the blood–brain barrier
Phillips et al. (1998) (in vitro)	813.5625 MHz 836.55 MHz	iDEN TDMA	2, 21 h 2, 21 h	0.0024		DNA damage in human leukemia cells
Pologea-Moraru et al. (2002) (in vitro)	2.45 GHz		1 h		15	Change in membrane of cells in the retina
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz	GSM (50 Hz pulses, 20 μs pulse length)	1–7 days postcoitum	0.0005		Exposure during early gestation affected kidney development
Roux et al. (2006a) (in vivo) (tomato whole body)	900 MHz				7	Gene expression and energy metabolism
Roux et al. (2006b) (in vivo) (plant whole body)	900 MHz				7	Energy metabolism
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz	GSM	2 h	0.02		Nerve cell damage in brain
Sarimov et al. (2004) (in vitro)	895–915 MHz	GSM	30 min	0.0054		Human lymphocyte chromatin affected similar to stress response
Schwartz et al. (1990) (in vitro)	240 MHz	CW and sinusoidal modulation at 0.5 and 16 Hz, effect only observed at 16 Hz modulation	30 min	0.00015		Calcium movement in the heart
Schwarz et al. (2008) (in vitro)	1950 MHz	UMTS	24 h	0.05		Genes in human fibroblasts
Somosy et al. (1991) (in vitro)	2.45 GHz	CW and 16 Hz square-modulation, modulated field more potent than CW		0.024		Molecular and structural changes in cells of mouse embryos
Stagg et al. (1997) (in vitro)	836.55 MHz	TDMA duty cycle 33%	24 h	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division
Stankiewicz et al. (2006) (in vitro)	900 MHz	GSM 217 Hz pulses, 577 ms width		0.024		Immune activities of human white blood cells
Tattersall et al. (2001) (in vitro)	700 MHz	CW	5–15 min	0.0016		Function of the hippocampus
Velizarov et al. (1999) (in vitro)	960 MHz	GSM 217 Hz square-pulse, duty cycle 12%	30 min	0.000021		Decrease in proliferation of human epithelial amnion cells
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz	1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM, direction of response depended on AM frequency		0.015		Functions of the immune system
Vian et al. (2006) (in vivo) plant	900 MHz				7	Stress gene expression
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz 900 MHz	Square-wave modulated at 217 Hz CW, 16 Hz, 50 Hz, and 30 KHz modulations		0.001		Calcium concentration in heart muscle cells of guinea pig
Yurekli et al. (2006) (in vivo) (rat whole body)	945 MHz	GSM, 217 Hz pulse-modulation	7 h/day, 8 days	0.0113		Free radical chemistry

Note: These papers gave either specific absorption rate, SAR, (W/kg) or power density (μW/cm²) of exposure. (Studies that did not contain these values were excluded). AM, amplitude modulated or amplitude modulation; CW, continuous wave; GSM, global system for mobile communication; iDEN, integrated digital enhanced network; TDMA, time division multiple access; TETRA, terrestrial trunked radio; UMTS, universal mobile telecommunications system.

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> "Stating that the current level of radiation (electromagnetic field, EMF) emitted by mobile phone towers was still high, Girish Kumar, Professor, Department of Electrical Engineering, IIT Bombay, on Saturday, urged the Centre to reduce the radiation level further.
> The mobile tower radiation had been reduced [in India] from 45,000 milliwatt per square metre to 450 milliwatt a few years ago. It should be reduced to 10 milliwatt, he said ...."
>
> Note: The FCC allows the American general public to be exposed to up to 5,800 milliwatts per square meter.

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Monday, May 2, 2016

Does long-term exposure to 4G LTE cell phone radiation impair cell phone users' health?

Following is a summary of the second study published on the effects of **4th generation** LTE cell phone radiation on the brain activity of cell phone users by the China Academy of Telecommunication Research of the Ministry of Industry and Information Technology.

The original study showed that 30 minutes of exposure to LTE phone radiation affected brain activity in the left superior temporal gyrus, left middle temporal gyrus, right superior temporal gyrus, right medial frontal gyrus and right paracentral lobule. The current study found that a 30-minute exposure to LTE radiation modulated the EEG in the alpha and beta bands at the frontal region of the near and remote sides, and at the temporal region on the near side.

By the end of 2013, 100 million cell phones in the U.S. operated on LTE. This number worldwide is expected to exceed 1 billion by the end of this year. Yet the one major study cell phone study being conducted in the U.S. examines the effects of **2nd generation** cell phone technology.

Why don't the U.S. and other major nations conduct biological and health effects research on the latest cell phone and wireless technologies?

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Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands

Yang L, Chen Q, Lv B, Wu T. Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands. Clin EEG Neurosci. 2016 Apr 25. pii: 1550059416644887. [Epub ahead of print]

Abstract

Long-term evolution (LTE) wireless telecommunication systems are widely used globally, which has raised a concern that exposure to electromagnetic fields (EMF) emitted from LTE devices can change human neural function. To date, few studies have been conducted on the effect of exposure to LTE EMF. Here, we evaluated the changes in electroencephalogram (EEG) due to LTE EMF exposure. An LTE EMF exposure system with a stable power emission, which was equivalent to the maximum emission from an LTE mobile phone, was used to radiate the subjects. Numerical simulations were conducted to ensure that the specific absorption rate in the subject's head was below the safety limits. Exposure to LTE EMF reduced the spectral power and the interhemispheric coherence in the alpha and beta bands of the frontal and temporal brain regions. No significant change was observed in the spectral power and the inter-hemispheric coherence in different timeslots during and after the exposure. These findings also corroborated those of our previous study using functional magnetic resonant imaging.

http://1.usa.gov/2475GM3

Excerpts

".. the results of resting state EEG experiments have been contradictory. For example, some studies have reported enhancement of the alpha (8-12 Hz) and beta (13-30 Hz) band power values after exposure to pulse-modulated 450- and 900-MHz signals,6,7 pulse-modulated magnetic fields,8 and active mobile phone signals.9,10 In contrast, some studies have shown decreased alpha band activity after 20 minutes of extremely low-frequency EMF exposure,11,12 or 5 minutes of magnetic field exposure,13 or global system for mobile communications (GSM) EMF exposure.14 Many studies also found no changes in the EEG after either modulated or unmodulated EMF exposure.15-17 These inconsistencies could be attributed not only to the differences in the signal type, the modulation, the exposure frequency, the exposure intensity individual anatomy, the ages of the subjects, and the exposure duration16,18-20 but also to the lack of rigorous experimental designs. Most of the previously published studies have focused on GSM,3 WiFi,21 and Universal Mobile Telecommunications System (UMTS),10 signals. An emerging technology, "longterm evolution" (LTE) wireless service, has been deployed since 2009 and the number of global LTE subscribers is expected to reach 1.37 billion by the end of 2015.22 Other than our previous functional magnetic resonance imaging (fMRI) study,23 there are very few reports on the effect of exposure to LTE EMF on brain function. We previously found that 30 minutes of exposure to LTE EMF modulated the spontaneous low-frequency fluctuations.23 We were interested in confirming our previous results using another neurophysiological method and also sought to assess the evolution of the effect over time during such exposure. In this article, we have investigated for the first time the changes in the resting state EEG caused by exposure to LTE signals. The exposure dose was below the current safety limit. In order to assess brain activities on different levels, we evaluated spectral power and interhemispheric coherence, which allowed investigation of EEG changes in specific brain regions, as well as their correlations, at different time points. We show that exposure to LTE EMF decreased the alpha and beta band power spectrum and interhemisphere coherence."

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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

- ► 2018 (9)
- ► 2017 (39)
- ▼ 2016 (32)
  - ► December (2)
  - ► November (1)
  - ► October (3)
  - ► September (4)
  - ► August (5)
  - ► July (4)
  - ► June (2)
  - ▼ May (4)
    - Government Failure to Address Wireless Radia
    - Should Cellphones Have Warning Labels? (Wa
    - Does long-term exposure to 4G LTE cell phone
    - Electromagnetic Radiation Safety: What are the
  - ► April (2)
  - ► February (3)
  - ► January (2)
- ► 2015 (32)
- ► 2014 (11)
- ► 2013 (41)

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

"The age of the subjects was 30.2 ± 2.7 years."

"A plastic spacer of 1 cm was used to maintain the distance between the right ear and a standard dipole. We applied 2 power meters (E4416A, Keysight, Santa Clara, CA, USA) to ensure a constant incident power to the emission dipole.25 The power delivered to the dipole was 24 dBm (peak value), equivalent to a theoretical maximum emission by an LTE terminal."

"All 25 subjects participated in the double-blind and counterbalanced experiment."

"The experiment included 2 sessions, which were separated by 1 week. Each session lasted 50 minutes and comprised 5 time slots. We indicated each time slot (10 minutes) in a session as sub1 to sub5. The radiation dipole was power off for the first (preexposure, sub1) and the last 10 minutes (postexposure, sub5) timeslots. Subjects were exposed to real EMF exposure in the 3 time slots (sub2 to sub4) between the first and the last 10 minutes in only 1 of the 2 sessions. The order of the 2 sessions was randomly selected per subject. The subjects were not informed of the sequence of each session; however, they were aware of the possibility of being exposed. On the other hand, the staff who analyzed the data did not know the sources of the EEG traces."

"The simulations yielded 1.34 W/kg (pSAR10g) and 1.96 W/kg (pSAR1g), with the electrodes, and 1.27 W/kg (pSAR10g) and 1.78 W/kg (pSAR1g), without the electrodes (Figure 2) when the dipole emitted radiation. Therefore, the presence of the EEG electrodes increased pSAR10g and pSAR1g by about 5.5% and 10.1%, respectively. Accordingly, the maximum resultant temperature increase was no more than 0.1°C ...."

"Previous studies on GSM and UMTS signal exposure frequently reported changes in interhemispheric coherence18,20 and the spectral power12 in the alpha band in the frontal and temporal regions, which were also confirmed by our results on LTE EMF exposure. Moreover, modulation of the power spectrum in the beta band, including both an increase and a decrease, was reported.10,38 Several reasons may account for the inconsistency. First, the signal frequency and its modulation influenced the affected EEG band: for example, exposure to 2G signals affect the alpha rhythms, whilst exposure to 3G signals do not.10,19 In contrast, the modulated 450-MHz signals of various intensities can change beta activity much more markedly than alpha band power.39 Second, gender and the individual sensitivity38,40 may influence the effect on different bands. Hence, we attempted to reduce the variability by enrolling the subjects with the same gender and age."

"In particular, power spectral analysis has shown significant differences in the left frontal brain regions, that is, the remote side, on exposure. This may be associated with modulation of neural activity in the remote/contralateral brain regions. The remote effects of EMF have been observed in many previous studies.2,9,41,42 Our results reconfirmed that the effects were also seen with LTE EMF exposure."

"The power spectrum and the interhemispheric coherence did not differ significantly over sub2 to sub5. Thus, the observed effect did not change with the exposure time and the effect was therefore not developing. **The reduction in alpha band activity has been associated with a decrease in individual information-processing ability, alertness, and cognitive performance. 16,43-48 The decrease in beta band activity could be interpreted as decreased alertness, arousal, and excitement 49 or a low level of fatigue. 50** Notably, EEG power fluctuation was not in one-one correspondence with the change in behavioral/cognitive performance which should be evaluated by specifically designed experiments as the report by Haarala et al.51 **No conclusion could be obtained by our study that the present EMF exposure affected the subjects' cognitive abilities."**

"This work studied EEG changes caused by LTE EMF exposure. An exposure system with a fixed power incident to a radiation dipole was used; this simulation demonstrated that the SAR was within the safety limits. LTE EMF exposure modulated the EEG in the alpha and beta bands at the frontal region of the near and remote sides, and at the temporal region on the near side. No developing effect was found in the periods during and after the exposure. Our results agreed to some extent with those of our previous fMRI study on LTE exposure. Our finding indicated that the LTE EMF exposure with the intensity beneath the safety limits could modulate the brain activities."

"Future studies should focus on the correlation of EEG changes with spatial SAR distribution. By taking individual anatomical structure into consideration, a precise dose-effect relationship can be established. EEG changes with a finer temporal resolution during the exposure session should also be evaluated."

Prior LTE study

23. Lv B, Chen Z, Wu T, et al. The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure. Clin Neurophysiol. 2014;125:277-286. http://1.usa.gov/1gTqxVr

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Public health implications of wireless technologies

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Abstract

Global exposures to emerging wireless technologies from applications including mobile phones, cordless phones, DECT phones, WI-FI, WLAN, WiMAX, wireless internet, baby monitors, and others may present serious public health consequences. Evidence supporting a public health risk is documented in the BioInitiative Report. New, biologically based public exposure standards for chronic exposure to low-intensity exposures are warranted. Existing safety standards are obsolete because they are based solely on thermal effects from acute exposures. The rapidly expanding development of new wireless technologies and the long latency for the development of such serious diseases as brain cancers means that failure to take immediate action to reduce risks may result in an epidemic of potentially fatal diseases in the future. Regardless of whether or not the associations are causal, the strengths of the associations are sufficiently strong that in the opinion of the authors, taking action to reduce exposures is imperative, especially for the fetus and children. Such action is fully compatible with the precautionary principle, as enunciated by the Rio Declaration, the European Constitution Principle on Health (Section 3.1) and the European Union Treaties Article 174.

Keywords: Wireless technology; Brain cancer; Radiofrequency; Cell phones; Wireless antenna facilities; Childrens' health

1. Introduction and background

Exposure to electromagnetic fields (EMF) has been linked to a variety of adverse health outcomes that may have significant public health consequences [1–13]. The most serious health endpoints that have been reported to be associated with extremely low frequency (ELF) and/or RF include childhood and adult leukemia, childhood and adult brain tumors, and increased risk of the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS). In addition, there are reports of increased risk of breast cancer in both men and women, genotoxic effects (DNA damage and micronucleation), pathological leakage of the blood–brain barrier, altered immune function including increased allergic and inflammatory responses, miscarriage and some cardiovascular effects [1–13]. Insomnia (sleep disruption) is reported in studies of people living in very low-intensity RF environments with WI-FI and cell tower-level exposures [85–93]. Short-term effects on cognition, memory and learning, behavior, reaction time, attention and concentration, and altered brainwave activity (altered EEG) are also reported in the scientific literature [94–107]. Biophysical mechanisms that may account for such effects can be found in various articles and reviews [136–144].

The public health implications of emerging wireless technologies are enormous because there has been a very rapid global deployment of both old and new forms in the last 15 years. In the United States, the deployment of wireless infrastructure has accelerated greatly in the last few years with 220,500 cell sites in 2008 [14–16]. Eighty-four percent of the population of the US own cell phones [16]. Annualized wireless revenues in 2008 will reach $144 billion and US spending on wireless communications will reach $212 billion by 2008. Based on the current 15% annual growth rate enjoyed by the wireless industry, in the next 5 years wireless will become a larger sector of the US economy than both the agriculture and automobile sectors. The annualized use of cell phones in the US is estimated to be 2.23 trillion minutes in 2008 [16]. There are 2.2 billion users of cell phones worldwide in 2008 [17] and many million more users of cordless phones.

Over 75 billion text messages were sent in the United States, compared with 7.2 billion in June 2005, according to

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CTIA, the Wireless Association, the leading industry trade group [16]. The consumer research company Nielsen Mobile, which tracked 50,000 individual customer accounts in the second quarter of this year, found that Americans each sent or received 357 text messages a month then, compared with 204 phone calls. That was the second consecutive quarter in which mobile texting significantly surpassed the number of voice calls [17].

The Electronics Industries Alliance (EIA) represents 80% of the $550 billion US electronics industry "that provides two million jobs for American workers." Its members include companies from the consumer electronics and telecommunications industries, among others [17].

There is intense industry competition for market share. Telecom taxes form an immense revenue generator for the government sector. Sale of the airwaves (auctions selling off wireless bandwidth) is a multi-million dollar industry for governments, and multi-billion dollar global advertising budgets are common. Lobbying dollars from the telecom-related industries are estimated to be $300 million annually. The media is nearly silent on health issues, perhaps in part because of global advertising revenues that compromise journalistic independence and discourage balanced coverage of health, equity and economic issues.

2. Evidence supporting a public health risk

Even if there is only a small risk to health from chronic use of and exposure to wireless technologies, there is the potential for a profound public health impact. RF radiation now saturates the airwaves, resulting in exposure to both users and non-users. The effects are both short-term (sleep disruption, hormone disruption, impairment of cognitive function, concentration, attention, behavior, and well-being) and they are almost certainly long-term (generational impacts on health secondary to DNA damage, physiological stress, altered immune function, electrosensitivity, miscarriage risks, effects on sperm quality and motility leading to infertiility, increased rates of cancer, and neurological diseases including Alzheimer's disease and ALS—at least for ELF exposures). (Chapters 5–12 of the BioInitiative Report [1] and papers in this Supplement.)

There is credible scientific evidence that RF exposures cause changes in cell membrane function, metabolism and cellular signal communication, as well as activation of proto-oncogenes and triggering of the production of stress proteins at exposure levels below current regulatory limits. There is also generation of reactive oxygen species, which cause DNA damage, chromosomal aberrations and nerve cell death. A number of different effects on the central nervous system have also been documented, including activation of the endogenous opioid systems, changes in brain function including memory loss, slowed learning, motor dysfunction and performance impairment in children, and increased frequency of headaches, fatigue and sleep disorders. Melatonin secretion is reduced, resulting in altered circadian rhythms and disruption of several physiological functions. (Chapters 5–12 of the BioInitiative Report [1] and papers in this Supplement.)

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable [1,19]. The young are also largely unable to remove themselves from such environments. Second-hand non-ionizing radiation, like second-hand smoke may be considered of public health concern based on the evidence at hand.

2.1. Malignant brain tumors

At present, the most persuasive evidence for cancer resulting from RF exposure is that there is a significantly increased risk of malignant glioma in individuals that have used a mobile phone for 10 or more years, with the risk being elevated only on the side of the head on which the phone is used regularly (ipsilateral use) [1,3,4,6–8,18]. While the risk for adults after 10 or more years of use is reported to be more than doubled, there is some evidence beginning to appear that indicates that the risk is greater if the individual begins to use a mobile phone at younger ages. Hardell et al. [18] reported higher odds ratios in the 20–29-year-old group than other age ranges after more than 5 years of use of either analog or cordless phones. Recently in a London symposium Hardell reported that after even just 1 or more years of use there is a 5.2-fold elevated risk in children who begin use of mobile phones before the age of 20 years, whereas for all ages the odds ratio was 1.4. Studies from Israel have found that the risk of parotid gland tumors (a salivary gland in the cheek) is increased with heavy cell phone use [7]. The risk of acoustic neuroma (a benign but space-occupying tumor on the auditory nerve) is also significantly increased on the ipsilateral side of the head after 10 or more years of mobile phone use [1,3]. This relationship has also been documented in some of the published reports of the WHO Interphone Study, a decade-long 13-country international assessment of cell phone risks and cancer [6,8].

Kundi reports that "(E)pidemiological evidence compiled in the last 10 years starts to indicate an increased risk, in particular for brain tumors (glioma, meningioma, acoustic neuroma), from mobile phone use. Considering biases that may have been operating in most studies the risk estimates are rather too low, although recall bias could have increased risk estimates. The net result, when considering the different errors and their impact is still an elevated risk" [19].

The latency for most brain tumors is 20 years or more when related to other environmental agents, for example, to X-ray exposure. Yet, for cell phone use the increased risks are occurring much sooner than twenty years, as early as 10 years for brain tumors in adults and with even shorter latencies in children. This suggests that we may currently be significantly underestimating the impact of current levels of use of RF technology, since we do not know how long the average latency period really is. If it is 20 years, then the risk rate will likely be much higher than an overall doubling of risk for cell phone users if the peak comes later than 10 years. It may also signal very troubling risks for those who start using cell phones, and perhaps all wireless devices, in early childhood. We may not have proof of effect for decades until many hundreds of thousands of new cases of malignant gliomas are set in motion by long-term cell phone use.

The preliminary evidence that mobile phone use at younger ages may lead to greater risk than for older persons is of particular concern. There is a large body of evidence that childhood exposure to environmental agents poses greater risk to health than comparable exposure during adulthood [20,21]. There is reason to expect that children would be more susceptible to the effects of EMF exposure since they are growing, their rate of cellular activity and division is more rapid, and they may be more at risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years so that neurological changes may be of great importance to normal development, cognition, learning, and behavior.

A greater vulnerability of children to developing brain cancer from mobile phone use may be the consequence of a combination of patterns of use, stage of development and physical characteristics related to exposure. In addition to the fact that the brain continues to develop through the teen years, many young children and teenagers now spend very large periods of time using mobile phones. The brain is the main target organ of cell phones and cordless phones, with highest exposure to the same side as the phone is used. Further, due to anatomical reasons, the brain of a child is more exposed to RF radiation than the brain of an adult [22,23]. This is caused by the smaller brain size, a thinner pinna of the ear, thinner skin and thinner skull bone permitting deeper penetration into the child's brain. A recent French study showed that children absorb twice the RF from cell phone use as do adults [24].

In addition to concerns about cancer, there is evidence for short-term effects of RF exposure on cognition, memory and learning, behavior, reaction time, attention and concentration, altered brainwave activity (altered EEG) [95–108], and all of these effects argue for extreme caution with regard to exposure of children. The development of children into adults is characterized by faster cell division during growth, the long period needed to fully develop and mature all organ systems, and the need for properly synchronized neural development until early adulthood. Chronic, cumulative RF exposures may alter the normal growth and development of children and adversely affect their development and capacity for normal learning, nervous system development, behavior and judgment [1,97,102].

Prenatal exposure to EMF has been identified as a possible risk factor for childhood leukemia (1). Maternal use of cell phones has been reported to adversely affect fetal brain development, resulting in behavioral problems in those children by the time they reach school age [25]. Their exposure is involuntary in all cases. Children are largely unable to remove themselves from exposures to harmful substances in their environments.

2.2. Plausible biological mechanisms for a relationship between RF exposure and cancer

2.2.1. DNA damage and oxidative stress

Damage to DNA from ELF and from RF cell phone frequencies at very low intensities (far below FCC and ICNIRP safety limits) has been demonstrated in many studies [1,2,26–35]. Both single- and double-strand DNA damage have been reported by various researchers in different laboratories. This is damage to the human genome, and can lead to mutations which can be inherited, or which can cause cancer, or both.

Non-ionizing radiation is assumed to be of too low energy to cause direct DNA damage. However both ELF and RF radiation induce reactive oxygen species, free radicals that react with cellular molecules including DNA. Free-radical production and/or the failure to repair DNA damage (secondary to damage to the enzymes that repair damage) created by such exposures can lead to mutations. Whether it is greater free-radical production, reduction in anti-oxidant protection or reduced repair capacity, the result will be altered DNA, increased risk of cancer, impaired or delayed healing, and premature aging [36–54]. Exposures have also been linked to decreased melatonin production, which is a plausible biological mechanism for decreased cancer surveillance in the body, and increased cancer risk [34,39,44,46,47,49,50,54]. An increased risk of cancers and a decrease in survival has been reported in numerous studies of ELF and RF [55–69].

2.2.2. Stress proteins (heat shock proteins or HSP)

Another well-documented effect of exposure to low-intensity ELF and RF is the creation of stress proteins (heat shock proteins) that signal a cell is being placed under physiological stress) [70–80]. The HSP response is generally associated with heat shock, exposure to toxic chemicals and heavy metals, and other environmental insults. HSP is a signal of cells in distress. Plants, animals and bacteria all produce stress proteins to survive environmental stressors like high temperatures, lack of oxygen, heavy metal poisoning, and oxidative stress.

We can now add ELF and RF exposures to this list of environmental stressors that cause a physiological stress response. Very low-level ELF and RF exposures can cause cells to produce stress proteins, meaning that the cell recognizes ELF and RF exposures as harmful. This is another important way in which scientists have documented that ELF and RF exposures can be harmful, and it happens at levels far below the existing public safety standards. An additional concern is that if the stress goes on too long, the protective effect is diminished. The reduced response with prolonged exposure means the cell is less protected against

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damage, and this is why prolonged or chronic exposures may be harmful, even at very low intensities.

2.2.3. RF-induced gene expression changes

Many environment agents cause diseases, including cancer, not by direct damage to DNA but rather by up- or down-regulation of genes that regulate cell growth and function. Usually there are many genes whose expression is changed, and it is difficult to determine the exact changes responsible for the disease. Both ELF and RF exposures have been shown to result in altered gene expression. Olivares-Banuelos et al. [81] found that ELF exposure of chromaffin cells resulted in changed expression of 53 transcripts. Zhao et al. [82] investigated the gene expression profile of rat neurons exposed to 1800 MHz RF fields (2 W/kg) and found 24 up-regulated genes and 10 down-regulated genes after a 24-h exposure. The altered genes were involved in multiple cellular functions including cytoskeleton, signal transduction pathways and metabolism. Kariene et al. [83] exposed human skin to mobile phone radiation, and found by punch biopsy that 8 proteins were significantly altered in expression, consistent with gene induction. Several other studies have found altered gene expression following RF exposure, although none have been found that explain specific disease states [84].

DNA activation at very low ELF and RF levels, as in the stress response, and DNA damage (strand breaks and micronuclei) at higher levels, are molecular precursors to changes that are believed to lead to cancer. These, along with gene induction, provide plausible biological mechanisms linking exposure to cancer.

The biochemical pathways that are activated are the same for ELF and for RF exposures, and are non-thermal (do not require heating or induced electrical currents). This is true for the stress response, DNA damage, generation of reactive oxygen species as well as gene induction. Thus it is not surprising that the major cancers resulting from exposure to ELF and RF are the same, namely leukemia and brain cancer. The safety standards for both ELF and RF, based on protection from heating, are irrelevant and not protective. ELF exposure levels of only 5–10 mG have been shown to activate the stress response genes (http://www.bioinitiative.org, Sections 1 and 7 [1]).

3. Sleep, cognitive function and performance

The relationship of good sleep to cognition, performance and healing is well recognized. Sleep is a profoundly important factor in proper healing, anti-inflammatory benefits, reduction in physical symptoms of such as tendonitis, over-use syndrome, fatigue-induced lethargy, cognition and learning. Incomplete or slowed physiological recovery is common when sleep is impaired. Circadian rhythms that normalize stress hormone production (cortisol, for example) depend on synchronized sleep patterns.

People who are chronically exposed to low-level wireless antenna emissions report symptoms such as problems in sleeping (insomnia), as well as other symptoms that include fatigue, headache, dizziness, grogginess, lack of concentration, memory problems, ringing in the ears (tinnitus), problems with balance and orientation, and difficulty in multi-tasking [85–93,99]. In children, exposures to cell phone radiation have resulted in changes in brain oscillatory activity during some memory tasks [97,102]. Cognitive impairment, loss of mental concentration, distraction, speeded mental function but lowered accuracy, impaired judgment, delayed reaction time, spatial disorientation, dizziness, fatigue, headache, slower motor skills and reduced learning ability in children and adults have all been reported [85–108].

These symptoms are more common among "electrosensitive" individuals, although electrosensitivity has not been documented in double-blind tests of individual identifying themselves as being electrosensitive as compared to controls [109,110]. However people traveling to laboratories for testing are pre-exposed to a multitude of RF and ELF exposures, so they may already be symptomatic prior to actual testing. There is also evidence that RF exposures testing behavioral changes show delayed results; effects are observed after termination of RF exposure. This suggests a persistent change in the nervous system that may be evident only after time has passed, so is not observed during a short testing period.

3.1. Plausible biological mechanisms for neurobehavioral effects

3.1.1. The melatonin hypothesis

While there remains controversy as to the degree that RF and ELF fields alter neurobehavioral function, emerging evidence provides a plausible mechanism for both effects on sleep and cognition. Sleep is controlled by the central circadian oscillator in the suprachiasmatic nucleus, located in the hypothalamus. The activity of this central circadian oscillator is, in turn, controlled by the hormone, melatonin, which is released from the pineal gland [111]. There is considerable evidence that ELF exposure reduces the release of melatonin from the pineal gland—see Section 12 of the Bioinitiative Report [1]. There has been less study of the effects of RF exposure on melatonin release, but investigations have demonstrated a reduced excretion of the urinary metabolite of melatonin among persons using a mobile phone for more than 25 min per day [112]. In a study of women living near to radio and television transmitters, Clark et al. [113] found no effect on urinary melatonin metabolite excretion among pre-menopausal women, but a strong effect in post-menopausal women.

The "melatonin hypothesis" also provides a possible basis for other reported effects of EMFs. Melatonin has important actions on learning and memory, and inhibits electrophysiological components of learning in some but not all areas of the brain [114,115]. Melatonin has properties as a free-radical scavenger and anti-oxidant [116], and consequently,

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a reduction in melatonin levels would be expected to increase susceptibility to cancer and cellular damage. Melatonin could also be the key to understanding the relationship between EMF exposure and Alzheimer's disease. Noonan et al. [117] reported that there was an inverse relationship between excretion of the melatonin metabolite and the 1–42 amino acid form of amyloid beta in electric utility workers. This form of amyloid beta has been found to be elevated in Alzheimer's patients.

3.1.2. Blood–brain barrier alterations

Central nervous system effects of EMFs may also be secondary to damage to the blood–brain barrier (BBB). The blood–brain barrier is a critical structure that prevents toxins and other large molecules that are in peripheral blood from having access to the brain matter itself. Salford et al. [118] have reported that a 2-h exposure of rats to GSM-900 radiation with a SAR of 2–200 mW/kg resulted in nerve cell damage. In a follow-up study, Eberhardt et al. report that 2-h exposures to cell phone GSM microwave RF resulted in leakage of albumin across the blood–brain barrier and neuronal death [119]. Neuronal albumin uptake was significantly correlated to occurrence of damaged neurons when measured at 28 days post-exposure. The lowest exposure level was 0.12 mW/kg (0.00012 W/kg) for 2 h. The highest exposure level was 120 mW/kg (0.12 W/kg). The weakest exposure level showed the greatest effect in opening the BBB [118]. Earlier blood–brain studies by Salford and Schirmacher [120,121] report similar effects.

4. What are sources of wireless radiation?

There are many overlapping sources of radiofrequency and microwave emissions in daily life, both from industrial sources (like cell towers) and from personal items [cell and cordless phones, personal digital assistants (PDAs), wireless routers, etc.]. Published data on typical levels found in some cities and from some sources are available at http://www.bioinitiative.org [1,122–124].

Cell phones are the single most important source of radiofrequency radiation to which we are exposed because of the relatively high exposure that results from the phone being held right against the head. Cell phones produce two types of emissions that should be considered. First, the radiofrequency radiation (typically microwave frequency radiation) is present. However, there is also the contribution of the switching battery pack that produces very high levels of extremely low frequency electromagnetic field [125–127].

Cordless telephones have not been widely recognized as similar in emissions to cell phones, but they can and do produce significant RF exposures. Since people tend to use them as substitutes for in-home and in-office corded or traditional telephones, they are often used for long periods of time. As the range of cordless phones has increased (the distance away that you can carry on a conversation is related to the power output of the phone), the more powerful the RF signal will be. Hence, newer cordless phones may in some cases be similar to the power output of cell phones. The cumulative emissions from cell and cordless phones taken together should be recognized when considering the relative risks of wireless communication exposures.

PDAs such as the BlackBerry, Treo and iPhone units are 'souped-up' versions of the original voice communication devices (cell phones). The often produce far higher ELF emissions than do cell phones because they use energy from the battery very intensively for powering color displays and during data transmission functions (email, sending and receiving large files, photos, etc.) [125–127]. ELF emissions have been reported from PDAs at several tens to several hundreds of milligauss. Evidence of significantly elevated ELF fields during normal use of the PDA has public health relevance and has been reported in at least three scientific papers [125,128,129]. In the context of repetitive, chronic exposure to significantly elevated ELF pulses from PDAs worn on the body, relevant health studies point to a possible relationship between ELF exposure and cancer and pregnancy outcomes [130–133].

We include discussion of the ELF literature for two reasons. As mentioned above ELF activates the same biology as RF, it contributes to the total EMF burden of the body. In addition, PDAs and cell phones emit both radiofrequency/microwave radiation (RF) and extremely low frequency ELF from the battery switching of the device (the power source). Studies show that some devices produce excessively high ELF exposures during voice and data transmission. ELF is already classified as a 2B (Possible) Carcinogen by IARC, which means that ELF is indisputably an issue to consider in the wireless technology debate. ELF has been classified as a Group 2B carcinogen for all humans, not just children. The strongest evidence came from epidemiological studies on childhood leukemia, but the designation applies to all humans, both adults and children [1,25].

Wireless headsets that allow for conversations with cell phones at a distance from the head itself reduce the emissions. Depending on the type of wireless device, they may operate (transmit signal) only during conversations or they may be operational continuously. The cumulative dose of wireless headsets has not been well characterized under either form of use. Substantial cumulative RF exposure would be expected if the user wears a wireless headset that transmits a signal continuously during the day. However a critical factor is where the cell phone is placed. If worn on a belt with a headset, the exposure to the brain is reduced but the exposure to the pelvis may be significant.

Cell towers (called "masts" in Europe and Scandinavian countries) are wireless antenna facilities that transmit the cell phone signals within communities. They are another major source of RF exposures for the public. They differ from RF exposures from wireless devices like cell phones in that they produce much lower RF levels (generally 0.05 to 1–2 $\mu W/cm^2$ in the first several hundred feet around them) in comparison to several hundred microwatts per centimeter squared for a cell phone held at the head. However they create a constant zone of elevated RF for up to 24 h per day. many hours per day, and the exposure is whole body rather than localized at the head. These facilities are the distribution system for wireless voice communications, internet connections and data transmission within communities. They are often erected on free-standing towers. They may be constructed on telephone poles or electrical poles. They may be built into the façade or rooftops of buildings behind wood screening. These are called stealth installations for wireless antenna facilities. Some installations are camouflaged to resemble 'false trees or rocks'. They emit RF to provide cell service to specific "cells" or locations that receive the signal.

Other forms of wireless transmission that are common in areas providing cell service are wireless land area networks (WLAN), (WiMAX) and WIFI networks. Some cities are installing city-wide WIFI service to allow any user on the street to log into the internet (without cables or wire connections). WIFI installations may have a signal reach for a few hundred feet where WiMAX installations may transmit signal more than 10 miles, so produce a stronger RF emission for those in close proximity. Each type has its particular signal strength and intended coverage area, but what they have in common is the production of continuous RF exposure for those within the area. We do not know what the cumulative exposure (dose) might be for people living, working or going to school in continuously elevated RF fields, nor are the possible health implications yet known. However, based on studies of populations near cell sites in general, there is a constellation of generally observed health symptoms that are reported to occur [85–107]. In this regard it is important to note that children living near to AM radio transmitters have been found to elevated risks of leukemia [134,135]. While AM radio RF fields are lower in frequency than that common in mobile phones, this is a total body irradiation with RF. The fact that leukemia, not brain cancer, is apparent in these studies suggests that leukemia is the cancer seen at the lowest levels of both ELF and RF fields under the circumstances of whole-body exposure.

Commercial surveillance systems or security gates pose an additional source of strong RF exposures. They are ubiquitous in department stores, markets and shops at the entry and exit points to discourage shoplifting and theft of goods. Security gates can produce excessively high RF exposures (although transitory) and have been associated with interference with pacemakers in heart patients. The exposure levels may approach thermal public safety limits in intensity, although no one expects a person to stand between the security gate bars for more than 6 min (safety limits for uncontrolled public access are variable depending on the frequency, but are all averaged over a 6-min exposure period).

RFID chips (radiofrequency identification chips) are being widely used to track purchases and for security of pets, and in some cases to keep track of patients with Alzheimer's disease and of children. RFID chips are implanted in fabrics, inserted in many types of commercial goods, and can be implanted under the skin. They create a detectable signal to track the location of people and goods.

5. Problems with existing public health standards (safety limits)

If the existing standards were adequate none of the effects documented above should occur at levels to which people are regularly exposed. The fact that these effects are seen with our current ambient levels of exposure means that our existing public safety standards are obsolete. It also means that new, biologically based public exposure standards for wireless technologies are urgently needed. Whether it is feasible to achieve low enough levels that still work and also protect health against effects of chronic RF exposure – for all age groups – is uncertain. Whether we can protect the public and still allow the kinds of wireless technology uses we see today is unknown.

The nature of electromagnetic field interactions with biological systems has been well studied [136–144]. For purposes of standard-setting processes for both ELF and RF, the hypothesis that tissue damage can result only from heating is the fundamental flaw in the misguided efforts to understand the basic biological mechanisms leading to health effects.

The thermal standard is clearly untenable as a measure of dose when EMF stimuli that differ by many orders of magnitude in energy can stimulate the same biological response. In the ELF range, the same biological changes occur as in the RF, and no change in temperature can even be detected. With DNA interactions the same biological responses are stimulated in ELF and RF ranges even though the frequencies of the stimuli differ by many orders of magnitude. The effects of EMF on DNA to initiate the stress response or to cause molecular damage reflect the same biology in different frequency ranges. For this reason it should be possible to develop a scale based on DNA biology, and use it to define EMF dose in different parts of the EM spectrum. We also see a continuous scale in DNA experiments that focus on molecular damage where single and double strand breaks have long been known to occur in the ionizing range, and recent studies have shown similar effects in both ELF and RF ranges [144].

Existing standard-setting bodies that regulate wireless technologies, assume that there are no bioeffects of concern at exposure levels that do not cause measurable heating. However, it has been established beyond any reasonable doubt that bioeffects and some adverse health effects occur at far lower levels of RF and ELF exposure where no heating (or induced current) occurs; some effects are shown to occur a thousand times or more below the existing public safety limits. New, biologically based public exposure limits are urgently needed. New wireless technologies for cell and cordless phones, other wireless communication and data transmission systems affect living organisms in new ways that our antiquated safety limits have not foreseen, nor protected against.

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The exposure of children to electromagnetic fields has not been studied extensively; in fact, the Federal Communications Commission (FCC) standards for exposure to radiofrequency radiation are based on the height, weight and stature of a 6-foot tall man, not scaled to children or adults of smaller stature. They do not take into account the unique susceptibility of growing children to exposures, nor are there studies of particular relevance to children.

In addition there is a problem in the consideration of the level of evidence taken into consideration by these bodies. There have not been adequate animal models shown to have cancer as an endpoint, and a perception that no single mechanism is proven to explain these associations. Thus these committees have tended to ignore or minimize the evidence for direct hazard to humans, and believe there is no proof of cause and effect. These bodies assume from the beginning that only conclusive scientific evidence (absolute proof) will be sufficient to warrant change, and refuse to take action on the basis of a growing body of evidence which provides early but consequential warning of risks.

The Radiofrequency Interagency Working Group of the US governmental agencies involved in RF matters (RFIAWG) issued a Guidelines Statement in June of 1999 that concluded the present RF standard "may not adequately protect the public" [145]. The RFIAWG identified fourteen (14) issues that they believe are needed in the planned revisions of ANSI/IEEE RF exposure guidelines including "to provide a strong and credible rationale to support RF exposure guidelines". In particular, the RFIAWG criticized the existing standards as not taking into account chronic, as opposed to acute exposures, modulated or pulsed radiation (digital or pulsed RF is proposed at this site), time-averaged measurements that may erase the unique characteristics of an intensity-modulated RF radiation that may be responsible for reported biologic effects, and stated the need for a comprehensive review of long-term, low-level exposure studies, neurological-behavioral effects and micronucleus assay studies (showing genetic damage from low-level RF) [145]. This important document from relevant US agencies questions existing standards in the following ways: (a) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation effects; (b) recognition of different safety criteria for acute and chronic exposures at non-thermal or low-intensity levels; (c) recognition of deficiencies in using time-averaged measurements of RF that does not differentiate between intensity-modulated RF and continuous wave (CW) exposure, and *therefore may not adequately protect the public*; (d) having standards based on adult males rather than considering children to be the most vulnerable group.

6. Prudent public health responses

Emerging environmental health problems require preventative public health responses even where scientific and medical uncertainties still exist, but where policy decisions today may greatly reduce human disease and societal costs tomorrow.

Policy decisions in public health must address some amount of uncertainty when balancing likely benefits and estimated costs. Although new insight will allow better appreciation of difficult issues, such as those occurring in environmental and occupational health, an expanded perspective may also enlarge the list of problems that need to be managed. Ignoring the problems carries its own costs (as deferring a decision is a decision in itself). With environmental and other public health problems becoming increasingly complex and international in scope, scientific documentation alone rarely justifies simple solutions [146].

Social issues regarding the controversy over public and occupational exposures to ELF and RF center on the resolute adherence to existing ICNIRP and FCC/IEEE standards by many countries, in the face of growing scientific evidence of health risks at far lower levels [10]. The composition of these committees, usually with excessive representation of the physics and engineering communities rather than public health professionals, results in a refusal to adopt biologically based exposure standards. Furthermore, there is widespread belief that governments are ignoring this evidence and there is widespread distrust of and lack of confidence in governments and their health agencies. The basis on which most review bodies and standard-setting agencies have avoided the conclusion that the science is strong enough to warrant new safety limits for ELF and RF is to require a demonstration of absolute proof before taking action. A causal level of evidence, or scientific certainty standard is implicit in nearly all reviews of the ELF and RF science, although this runs counter to good public health protection policies.

There is no question that global implementation of the safety standards proposed in the Bioinitiative Report, if implemented abruptly and without careful planning, have the potential to not only be very expensive but also disruptive of life and the economy as we know it. Action must be a balance of risk to cost to benefit. The major risk from maintaining the status quo is an increasing number of cancer cases, especially in young people, as well as neurobehavioral problems at increasing frequencies. The benefits of the status quo are expansion and continued development of communication technologies. But we suspect that the true costs of even existing technologies will only become much more apparent with time. Whether the costs of remedial action are worth the societal benefits is a formula that should reward precautionary behavior. Prudent corporate policies should be expected to address and avoid future risks and liabilities, otherwise, there is no market incentive to produce safe (and safer) products.

The deployment of new technologies is running ahead of any reasonable estimation of possible health impacts and estimates of probabilities, let alone a solid assessment of risk. However, what has been missing with regard to EMF has been an acknowledgement of the risk that is demonstrated by

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the scientific studies. There is clear evidence of risk, although the magnitude of the risk is uncertain, and the magnitude of doing nothing on the health effects cost to society is similarly uncertain. This situation is very similar to our history of dealing with the hazards of smoking decades ago, where the power of the industry to influence governments and even conflicts of interest within the public health community delayed action for more than a generation, with consequent loss of life and enormous extra health care costs to society. New standards are warranted now, based on the totality of scientific evidence; the risks of taking no-action, the large population at risk, costs associated with ignoring the problem in new and upgraded site selection and construction, and the loss of public trust by ignoring the problem.

Direct medical and rehabilitative health costs associated with treatment for diseases that are reasonably related to wireless technologies may be very large. Although there is uncertainty involved in how much disease is related to wireless exposures, the mere scale of the problem with several billion users of cell phones and even larger impacts on bystander populations (from cell site exposures, from other WI-FI and wireless exposures in-home and commercial use, etc.) the associated public health costs will likely be monumental. Furthermore the costs to families with cancers, neurological diseases or learning disabilities in children related in part or in whole to wireless technologies extend beyond medical costs. They may reasonably extend to family disruption and family psychological problems, losses in job productivity and income loss.

The history of governments and their official health agencies to deal with emerging and newly identified risks to health is not good [147–149]. This is particularly true where industry investments in new products and technologies occur without full recognition, disclosure or even knowledge of possible health consequences. Large economic investments in polluting industries often make for perilously slow regulatory action, and the public health consequences may be very great as a result [150,151].

Free markets do not internalize the costs to society of "guessing wrong". Unexpected or hidden health costs of new technologies may not be seen for many years, when the ability to recall or to identify the precise exposures related to disease outcomes is difficult or impossible. The penalty nearly always falls to the individual, the family or the taxpayer and not to the industry that benefits economically—at least in free-market economies. Thus, the profits go to industry but the costs may go to the individual who can suffer both diminished quality of life and health and economic disadvantage. If all disease endpoints that may be reasonably related to chronic exposure to electromagnetic fields are considered even a small attributable fraction for one or more industries, it will have enormous global impact on public health. The public health implications are immense. But they can be reduced by strong government and public health interventions providing information on alternatives to wireless technologies, public education campaigns, health advisories, requirements for redesign of wireless devices, proscription of use of wireless devices by children and teenagers, strong and independent research programs on causes and prevention of EMF-related diseases, and consultation with all stakeholders on issues relating to involuntary exposures (bystander or second-hand radiation exposures from wireless technologies) (Table 1).

Table 1
Public health implications of wireless technologies argue for change in governmental and health agency actions.

Secure US and EU legislative mandates for safer technologies for communication and data transmission, for security and surveillance needs.
Promote wired alternatives for voice and data communication (cable, fiber-optic)
Discourage or ban use of cell phones by children and young teen-agers
Provide permanent (unremovable) labels on cell phones "Not for use by children under the age of 16"
Implement national public education campaigns on health issues (cell phones, cordless phones, PDAs, wireless internet, city-wide WI-FI, WLAN and WiMAX exposures
Promote industry redesign for safer products: support innovation for alternatives and solutions
Slow or stop deployment of wireless technologies to discourage reliance on wireless technologies for communication and security needs
Put the burden of proof on industry to show "new wireless tech" is safe before deployment
Adopt and enforce restricted use areas for sensitive or more vulnerable segments of society including low-EMF environments in public areas and "No Cell" zones in airports, hospitals, schools
Acknowledge FCC and ICNIRP thermal safety standards are obsolete for wireless technologies
Appoint new standard-setting bodies familiar with biological effects to develop new guidelines for public safety limits.
Develop new biologically based standards that address low-intensity, chronic exposures
Require standard of evidence and level of proof = public health
Reject "causal" standard of evidence for taking action on science
Make industry financially liable for "guessing wrong" and ignoring health risks

The scientific information contained in this Supplement argues for thresholds or guidelines that are substantially below current FCC and ICNIRP standards for localized exposures to wireless devices and for whole-body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research. No assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000–10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

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It is likely that for both ELF and RF, as for other carcinogens, there is no threshold of exposure that is without risk, but the magnitude of the risk increases linearly with the level of exposure. Our society will not go back to the pre-electric and pre-wireless age, but the clear evidence of health hazards to the human population from exposure mandates that we develop ways in which to reduce exposure through education, new technologies and the establishment of biomedically based standards.

7. Conclusions and recommended actions

New ELF limits are warranted based on a public health analysis of the overall existing scientific evidence. These limits should reflect environmental levels of ELF that have been demonstrated to increase risk for childhood leukemia, and possibly other cancers and neurological diseases. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky. These levels are in the 2–4 milligauss (mG) range (0.2–0.4 μT), not in the 10 s of mG or 100 s of mG. The existing ICNIRP limit is 1000 mG (100 μT) and 904 mG (90.4 μT) in the US for ELF is outdated and based on faulty assumptions. These limits are can no longer be said to be protective of public health and they should be replaced. A safety buffer or safety factor should also be applied to a new, biologically based ELF limit, and the conventional approach is to add a safety factor lower than the risk level.

While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction. It is also recommended that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant (because of the possible link between childhood leukemia and *in utero* exposure to ELF). This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies. While it is not realistic to reconstruct all existing electrical distribution systems, in the short-term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged. These limits should reflect the exposures that are commonly associated with increased risk of childhood leukemia (in the 2–5 mG (0.2–0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Nearly all of the occupational studies for adult cancers and neurological diseases report their highest exposure category is 4 mG (0.4 μT) and above, so that new ELF limits should target the exposure ranges of interest, and not necessarily higher ranges.

Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

It is not prudent public health policy to wait any longer to adopt new public safety limits for ELF. These limits should reflect the exposures that are commonly associated with increased risk of childhood leukemia (in the 2–5 mG (0.2–0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

The rapid deployment of new wireless technologies that chronically expose people to pulsed RF at levels reported to cause bioeffects, which in turn, could reasonably be presumed to lead to serious health impacts, is a public health concern. There is suggestive to strongly suggestive evidence that RF exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes and can trigger the production of stress proteins at exposure levels below current regulatory limits. Resulting effects can include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free-radical production, activation of the endogenous opioid system, cell stress and premature aging, changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and fatigue, sleep disorders, neurodegenerative conditions, reduction in melatonin secretion and cancers (BioInitiative Report Chapters 5–10, 12) [1].

This information now argues for thresholds or guidelines that are substantially below current FCC and ICNIPR standards for whole-body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research and no assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000–10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

A cautionary target level for pulsed RF exposures for ambient wireless that could be applied to RF sources from cell tower antennas, WI-FI, WI-MAX and other similar sources

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is proposed. The recommended cautionary target level is 0.1 microwatts per centimeter squared ($\mu W/cm^2$) (or 0.614 V per meter or V/m) for pulsed RF where these exposures affect the general public; this advisory is proportionate to the evidence and in accord with prudent public health policy. A precautionary limit of 0.1 $\mu W/cm^2$ should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. An outdoor precautionary limit of 0.1 $\mu W/cm^2$ would mean an even lower exposure level inside buildings, perhaps as low as 0.01 $\mu W/cm^2$. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

Broadcast facilities that chronically expose nearby residents to elevated RF levels from AM, FM and television antenna transmission are also of public health concern given the potential for very high RF exposures near these facilities (antenna farms). RF levels can be in the 10 s to several 100 s of $\mu W/cm^2$ in residential areas within half a mile of some broadcast sites (for example, Lookout Mountain, Colorado and Awbrey Butte, Bend, Oregon). Like wireless communication facilities, RF emissions from broadcast facilities that are located in, or expose residential populations and schools to elevated levels of RF will very likely need to be re-evaluated for safety.

For emissions from wireless devices (cell phones, personal digital assistant or PDA devices, etc.) there is enough evidence for increased risk of brain tumors and acoustic neuromas now to warrant intervention with respect to their use. Redesign of cell phones and PDAs could prevent direct head and eye exposure, for example, by designing new units so that they work only with a wired headset or on speakerphone mode.

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable. The young are also largely unable to remove themselves from such environments. Second-hand radiation, like second-hand smoke is an issue of public health concern based on the evidence at hand.

In summary, the following recommendations are made:

- ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky (at levels generally at 2 mG (0.2 μT) and above).
- While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction, It is also recommended for that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant. This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies.
- While it is not realistic to reconstruct all existing electrical distributions systems, in the short-term; steps to reduce exposure from these existing systems need to be initiated and should be encouraged, especially in places where children spend time.
- A precautionary limit of 0.1 $\mu W/cm^2$ (which is also 0.614 V per meter) should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure
cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Monday, July 18, 2016

Effects of Wireless Radiation on Birds and Other Wildlife

A Briefing Memo by Dr. Albert Manville

Albert M. Manville, II, Ph.D. A Briefing Memorandum: What We Know, Can Infer, and Don't Yet Know about Impacts from Thermal and Non-thermal Non-ionizing Radiation to Birds and Other Wildlife — for Public Release. July 14, 2016.

In this memo, Dr. Manville reviews the scientific literature that examines the impacts on wildlife from exposure to radio frequency radiation.

He observes that although the FCC has standards to protect humans from the heating (i.e., thermal) effects of wireless radiation exposure from cellular and broadcast towers, no standards exist to protect wildlife from thermal or non-thermal effects:

> "The radiation effects on wildlife need to be addressed by the Federal Communications Commission (FCC), the Environmental Protection Agency (EPA), the Department of Commerce, the U.S. Fish and Wildlife Service (FWS) and other governmental entities."

Dr. Manville concludes with the following statement:

> "In summary, we need to better understand ... how to address these growing and poorly understood radiation impacts to migratory birds, bees, bats, and myriad other wildlife. At present, given industry and agency intransigence ... massive amounts of money being spent to prevent addressing impacts from non-thermal radiation — not unlike the battles over tobacco and smoking — and a lack of significant, dedicated and reliable funding to advance independent field studies, ... we are left with few options. Currently, other than to proceed using the precautionary approach and keep emissions as low as reasonably achievable, we are at loggerheads in advancing meaningful guidelines, policies and regulations that address non-thermal effects...."

Dr. Manville recommends that the U.S. adopt the following recommendations because federally-protected wildlife species are currently in danger from RFR exposure:

> "We desperately need to conduct field research on thermal and non-thermal radiation impacts to wild migratory birds and other wildlife here in North America, similar to studies conducted in Europe...."
>
> "Studies need to be designed to better tease out and understand causality of thermal and non-thermal impacts from radiation on migratory birds.... efforts need to be made to begin developing exposure guidelines for migratory birds and other wildlife ..."
>
> "To minimize deleterious radiation exposures, these guidelines should include use of avoidance measures such as those developed by the electric utility industry for bird collision and electrocution avoidance ..."
>
> "Studies need to be conducted on the use of "faux" branches (i.e., metal arms that mimic pine or fir branches) on cell and/or FM towers intended to disguise the towers as trees, but provide nesting and roosting opportunities for migratory birds including Bald Eagles, which will almost certainly be impacted both by thermal and non-thermal radiation effects."
>
> "Agencies tasked with the protection, management, and research on migratory birds and other wildlife ... need to develop radiation policies that avoid or minimize impacts to migratory birds and other trust wildlife species."
>
> "As Levitt and Lai (2010) concluded, we do not actually need to know whether RFR effects are thermal or non-thermal to set exposure guidelines. Most scientists consider non-thermal effects as well established, even though the implications are not fully understood."
>
> "Given the rapidly growing database of peer-reviewed, published scientific studies (e.g., http://www.saferemr.com, School of Public Health, University of California, Berkeley), it is time that FCC considers thermal and non-thermal effects from EMR in their tower permitting, and incorporates changes into their rulemaking regarding 'effects of communication towers on migratory birds.'"

Dr. Albert Manville II is an adjunct faculty member at Johns Hopkins University. He served as a senior wildlife biologist with the U.S. Fish and Wildlife Service from 1997 to 2014. He chaired the Communication Tower Working Group, partnering with the communications industry, federal and state agencies, researchers, and non-profit organizations. He testified more than 40

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Electromagnetic Radiation Safety

Archive

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

times before Congress and other governmental bodies and published more 170 papers. For more information, see http://advanced.jhu.edu/about-us/faculty/albert-manville/.

Dr. Manville's memo is available at http://bit.ly/Manvillewildlife.

Also see:

Cell Tower Radiation Affects Wildlife: Dept. of Interior Attacks FCC

Cell Tower Health Effects

Labels: birds, broadcast towers, cell towers, eagles, FCC standards, Manville, protected species, radio frequency, wildlife

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Monday, March 24, 2014

Cell Tower Radiation Affects Wildlife: Dept. of Interior Attacks FCC

The Department of Interior charges that the FCC standards for cell phone radiation are outmoded and no longer applicable as they do not adequately protect wildlife.

The Director of the Office of Environmental Policy and Compliance of the United States Department of the Interior sent a letter to the National Telecommunications and Information Administration in the Department of Commerce which addresses the Interior Department's concern that cell tower radiation has had negative impacts on the health of migratory birds and other wildlife.

The Interior Department accused the Federal government of employing outdated radiation standards set by the Federal Communications Commission (FCC), a federal agency with no expertise in health. The standards are no longer applicable because they control only for overheating and do not protect organisms from the adverse effects of exposure to the low-intensity radiation produced by cell phones and cell towers:

> "the electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today."

The Department criticized the Federal government's proposed procedures for placement and operation of communication towers, and called for "independent, third-party peer-reviewed studies" in the U.S. to examine the effects of cell tower radiation on "migratory birds and other trust species."

Following are excerpts from the letter, dated Feb 7, 2014:

> "The Department believes that some of the proposed procedures are not consistent with Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds, which specifically requires federal agencies to develop and use principles, standards, and practices that will lessen the amount of unintentional take reasonably attributed to agency actions. The Department, through the Fish and Wildlife Service (FWS), finds that the proposals lack provisions necessary to conserve migratory bird resources, including eagles. The proposals also do not reflect current information regarding the effects of communication towers to birds. Our comments are intended to further clarify specific issues and address provisions in the proposals.
>
> The Department recommends revisions to the proposed procedures to better reflect the impacts to resources under our jurisdiction from communication towers. The placement and operation of communication towers, including un-guyed, unlit, monopole or lattice-designed structures, impact protected migratory birds in two significant ways. The first is by injury, crippling loss, and death from collisions with towers and their supporting guy-wire infrastructure, where present. The second significant issue associated with communication towers involves impacts from non-ionizing electromagnetic radiation emitted by them (See Attachment)."
>
> Enclosure A
>
> "The second significant issue associated with communication towers involves impacts from nonionizing electromagnetic radiation emitted by these structures. Radiation studies at cellular communication towers were begun circa 2000 in Europe and continue today on wild nesting birds. Study results have documented nest and site abandonment, plumage deterioration, locomotion problems, reduced survivorship, and death (e.g., Balmori 2005, Balmori and Hallberg 2007, and Everaert and Bauwens 2007). Nesting migratory birds and their offspring have apparently been affected by the radiation from cellular phone towers in the 900 and 1800 MHz frequency ranges- 915 MHz is the standard cellular phone frequency used in the United States. However, **the electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today. This is primarily due to the lower levels of radiation output from microwave-powered communication devices such as cellular telephones and other sources of point-to-point communications; levels typically lower than from microwave ovens. The problem, however, appears to focus on very low levels of non-ionizing electromagnetic radiation.** For example, in laboratory studies, T. Litovitz (personal communication) and DiCarlo et al. (2002) raised concerns about impacts of low-level, non-thermal electromagnetic radiation from the standard 915 MHz cell phone frequency on domestic chicken embryos- with some lethal results (Manville 2009, 2013a). Radiation at extremely low levels (0.0001 the level emitted by the average digital cellular telephone) caused heart attacks and the deaths of some chicken embryos subjected to hypoxic conditions in the laboratory while controls subjected to hypoxia were unaffected (DiCarlo et al. 2002). To date, no independent, third-party field studies have been conducted in North America on impacts of tower electromagnetic radiation on migratory birds. With the European field and U.S. laboratory evidence already available, independent, third-party peer-reviewed studies need to be conducted in the U.S. to begin examining the effects from radiation on migratory birds and other trust species."
>
> Radiation Impacts and Categorical Exclusions

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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

"There is a growing level of anecdotal evidence linking effects of non-thermal, non-ionizing electromagnetic radiation from communication towers on nesting and roosting wild birds and other wildlife in the U.S. Independent, third-party studies have yet to be conducted in the U.S. or Canada, although a peer-reviewed research protocol developed for the U.S. Forest Service by the Service's Division of Migratory Bird Management is available to study both collision and radiation impacts (Manville 2002). As previously mentioned, Balmori (2005) found strong negative correlations between levels of tower-emitted microwave radiation and bird breeding, nesting, and roosting in the vicinity of electromagnetic fields in Spain. He documented nest and site abandonment, plumage deterioration, locomotion problems, reduced survivorship, and death in House Sparrows, White Storks, Rock Doves, Magpies, Collared Doves, and other species. Though these species had historically been documented to roost and nest in these areas, Balmori (2005) did not observe these symptoms prior to construction and operation of the cellular phone towers. Balmori and Hallberg (2007) and Everaert and Bauwens (2007) found similar strong negative correlations among male House Sparrows. Under laboratory 'conditions, DiCarlo et al. (2002) raised troubling concerns about impacts of low-level, non-thermal electromagnetic radiation from the standard 915 MHz cell phone frequency on domestic chicken embryos- with some lethal results (Manville 2009). **Given the findings of the studies mentioned above, field studies should be conducted in North America to validate potential impacts of communication tower radiation both direct and indirect - to migratory birds and other trust wildlife species."**

The full text of the letter, the addendum and citations are available at: http://1.usa.gov/1jn3CZg

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Labels: birds, cell towers, electromagnetic radiation, FCC, research, standards, wildlife

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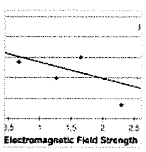
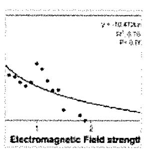
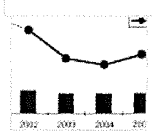
Outline

Effects on Wildlife

Figures (3)







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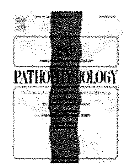

Electromagnetic pollution from phone masts. Effects on wildlife

Alfonso Balmori

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https://doi.org/10.1016/j.pathophys.2009.01.007

Abstract

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

A review on the impact of radiofrequency radiation from wireless telecommunications on wildlife is presented. Electromagnetic radiation is a form of environmental pollution which may hurt wildlife. Phone masts located in their living areas are irradiating continuously some species that could suffer long-term effects, like reduction of their natural defenses, deterioration of their health, problems in reproduction and reduction of their useful territory through habitat deterioration. Electromagnetic radiation can exert an aversive behavioral response in rats, bats and birds such as sparrows. Therefore microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts. To measure these effects urgent specific studies are necessary.

< **Previous** article

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Keywords

Effects on wildlife; Effects on birds; Electromagnetic radiation; Mammals; Microwaves; Mobile telecommunications; Non-thermal effects; Phone masts; Radiofrequencies

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

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PC Rcvd 01-18-18 to 01-25-18

A BRIEFING MEMORANDUM: What We Know, Can Infer, and Don't Yet Know about Impacts from Thermal and Non-thermal Non-ionizing Radiation to Birds and Other Wildlife — for Public Release

Albert M. Manville, II, Ph.D., C.W.B.[1]; Principal, *Wildlife and Habitat Conservation Solutions, LLC*[2]; Adjunct Professor, Johns Hopkins University's Krieger School of Arts and Sciences, DC Campus[3]; and former U.S. Fish and Wildlife Service agency lead on avian-structural impacts — including from radiation

July 14, 2016

Introduction

There continues to be an active yet unsettled controversy about current radiation safety standards and their effects on humans and wildlife (www.livingplanet.be), most especially (1) with the exponential growth of ultra-high frequency (UHF) microwave radiation of electromagnetic fields (EMF) ranging from 900 MHz to 2500 GHz. The 900 and 1800 MHz fields are commonly used in communication devices such as cellular (cell) telephones, their antennas, related "smart" phones, digital "smart meters," computer wi-fi communication systems, and other sources of point-to-point and Internet communication. Much less attention is being paid to (2) frequency modulated (FM) impacts on migratory birds, including bandwidths ranging from 70 to 110 MHz also briefly discussed in this memo.

However, as concluded in this memo, the impacts from radiation especially at the non-thermal level (thermal effects are generally pretty clear) have already been well documented. Most scientists consider non-thermal effects as well established even though the implications are not fully understood. For example, in the June 2016 *Scientific American Blog* (Portier and Leonard 2016), in response to the question, *"do cell phones cause cancer?"* The authors response was clear: *"probably, but it's complicated. The degree of risk almost certainly depends on the length and strength of exposure — but we still don't know how significant the actual danger is."* These same issues pertain to impacts to wildlife from both thermal and non-thermal effects emitted from cellular (cell) communication towers and FM antennas (discussed in detail beyond). The radiation effects on wildlife need to be addressed by the Federal Communications Commission (FCC), the Environmental Protection Agency (EPA), the Department of Commerce, the U.S. Fish and Wildlife Service (FWS) and other governmental entities.

Focusing in the remainder of this memo primarily on wildlife impacts, radiation effects can be characterized as *"near-field"* (near the source of radiation), *"far-field"* (some distance from the source) or *"intermediate."* Negative reports of near-field (i.e., very close to power sources such as on or very near cellular antennas and antenna arrays) thermal radiation effects (capable of heating tissue) on laboratory animals and wildlife have been published in the scientific literature since at least 1950. An example includes Clark 1950, cited in Tanner 1966. Much of the controversy about effects involves *"far field,"* non-thermal, low-level radiation impacts on humans, laboratory animals and wildlife. These are effects that can occur further away from the peak source of radiation (i.e., the tower antennas) due to signal attenuation, signal interference from objects and water droplets in the air, and other physical obstructions and disturbances. As concluded by Beason and Semm (2002), non-thermal effects had been the most difficult

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to explain because the mechanism by which they affect biological tissue was usually unknown or unclear. With much more current research and recent discoveries, the explanations are becoming much clearer as new research results become available and causality becomes more evident.

For human exposures, however, the FCC has operating rules. These rules require that power to cell and other broadcast towers must be turned off when workers are on and/or climbing the towers — due to health impacts and safety concerns from the thermal radiation.

Complicating the issue is the fact that there currently are no standards for wildlife exposure, including by the licensing and regulatory rules and procedures of the FCC. Other than a letter from the Interior Department's (DOI) Director of the Office of Environmental Policy and Compliance to the Commerce Department's National Telecommunications and Information Administration (NTIA; USDOI 2014) — Attachment A involving effects of tower collisions and non-thermal radiation on migratory birds which I authored — neither DOI nor the FWS have any policy or quasi policy that currently addresses radiation effects to migratory birds. Arguably, "effects" need to be determined by the EPA, which has no funding for this, and regulated as part of a National Environmental Policy Act (NEPA) site review for a proposed cell tower, including both thermal and non-thermal effects.

Undebatable, however, is the exponential growth of cell phone technologies with an estimated 7 billion cell phones now available worldwide to a human population of 7.4+ billion (NPR March 2016 news report based on 2015 data). With this growing cell phone use and the communication systems that transmit and receive the signals from them, as well as the paucity of government regulatory oversight, this memorandum very briefly summarizes some of the major studies and take-aways conducted primarily on laboratory animals and wildlife, especially migratory birds. The issue represents a growing and troubling concern since migratory birds are in decline (at least 36% of which are in trouble species-wide in North America [USFWS 2008]), and which face additional uncertain impacts from non-ionizing, thermal and non-thermal radiation (Manville 2015, 2016).

Tests on laboratory animals such as chicken embryos, mice and rats are used as surrogates to predict harm to humans, protected migratory birds and other wildlife which, for practical, ethical and legal reasons in the United States would not otherwise be subjected to laboratory studies on impacts from radiation. Furthermore, scientists generally do not want to perform harmful experiments on either humans or protected wildlife such as migratory birds. Studies on the negative effects of non-thermal radiation to wild birds in Europe are clearly relevant as predictors of what will/is likely/is happening to wild birds in North America — the Bald Eagle as such as example due to its population growth and growing proximity to existing and proposed cell towers. That is why the published research results from European avian studies are so troubling.

Biological Systems and EMF

Living systems operating in animals support a variety of oscillatory electrical and/or biochemical activities which have been well documented to be affected by EMF. However, the direct relationship between electromagnetic radiation and wildlife health continues to be complicated and in cases involving non-thermal effects, still unclear. We know, for example, that brain waves are electrical, the heartbeat is electrical, the cell membrane has an electric field potential, cell division is electrically influenced, communication between neurons is electrical, and all of the hormonal and enzymatic activities are electrically regulated. Even the chemical-mechanistic model of the human and animal anatomy is essentially an electromagnetic model, because all chemical reactions involve the sharing, trading, or exchange of electrons at the elemental level (www.livingplanet.be) as explained by scientist J. Everaert in his website.

As J. Everaert further explains, there are studies showing frequency-specific biological effects, and studies demonstrating that a high frequency signal modulated at certain low frequencies, or a signal that is pulsed, has more harmful effects than an unmodulated, steady carrier wave (www.livingplanet.be).

Early Studies on EMF in the Microwave Bandwidth

Dating back to at least 1950, Tanner (1966, citing Clark 1950) concluded that much had been published on effects of microwave radiation on body tissues and animals, but most of the early experiments were concerned with the production of heat and its physiological effects. Tanner et al. (1967) looked briefly at the effects of microwave radiation on domestic chickens, and concluded that thermal effects were manifested by a rise in temperature of the irradiated birds, which were accompanied by physiological responses based on intensity and duration of the radiation field — escape or avoidance — but that non-thermal effects that impacted other physiological systems were more difficult to discern. Tanner (1966) and Tanner et al. (1967) discovered that birds' feathers are known to have piezoelectric properties, capable of conducting EMF/RF deep within bird body cavities. This finding can help, in part, explain increased bird sensitivity to EMF/RF radiation. In this early research, however, it remains unclear if thermal and non-thermal effects were adequately differentiated.

Wasserman et al. (1984) conducted field studies on 12 flocks of migratory birds subjected to various combinations of microwave power density and duration under winter conditions at Monomet, MA, with birds from 2 additional flocks serving as controls. Increased levels of aggression were noted in some of the irradiated birds suggesting effects, but calling for further study.

More Recent EMF Studies on Birds, Other Wildlife and Laboratory Animals in the Microwave Bandwidth

There is an increasing body of published laboratory research that finds DNA damage at low intensity exposures — well below levels of thermal heating — which may be comparable to far field exposures from cell antennas. This body of work would apply to all species, including migratory birds, since DNA is DNA, whether single-strand or double helix. The first study to find such effects was conducted by H. Lai and N.P. Singh in 1995 (Lai and Singh 1995). Their work has since been replicated (e.g., Lai and Singh 1996, as well as in hundreds of other more recent published studies), performed in at least 14 laboratories worldwide. The take-home message: low level transmission of EMF from cell towers and other sources probably causes DNA damage. The laboratory research findings strongly infer this relationship. Since DNA is the primary building block and genetic "map" for the very growth, production, replication and survival of all living organisms, deleterious effects can be critical.

The entire thermal model and all FCC categorical exclusions for all of the devices we see today, rests on the incorrect assumption that low-level, non-ionizing non-thermal radiation cannot cause DNA breaks because it is *"so low-power"* (B. Levitt and H. Lai, Comments Filed Jointly to FCC, ET Docket No. 13-84, 2013). These issues need to be adequately addressed by the appropriate authorities including the FCC, EPA and FWS. Currently they are not.

In laboratory studies by T. Litovitz (2000 pers. comm.) and DiCarlo et al. (2002) from the standard 915 MHz cell phone frequency on domestic chicken embryos showed that radiation from extremely low levels (0.0001 the level emitted by the average digital cellular telephone) caused heart attacks and deaths in some embryos. Controls, however, were unaffected (DiCarlo et al. 2002). In replicated experiments, similar results were obtained by Grigor'ev (2003) and Xenos and Magras (2003). These findings are important since similar evidence exists for lethal and injurious impacts to wild birds in Europe from cell tower radiation, and based on anecdotal reports from the U.S., are very likely also occurring in North America (Manville 2016).

In field studies on wild birds in Spain, Balmori (2005) found strong negative correlations between levels of tower-emitted microwave radiation and bird breeding, nesting, roosting and survival in the vicinity of electromagnetic fields. He documented nest and site abandonment, plumage deterioration, locomotion problems, and death in Wood Storks, House Sparrows, Rock Doves, Magpies, Collared Doves, and other species. While these species had historically been documented to roost and nest in these areas, Balmori (2005) did not observe these symptoms prior to construction and operation of the cell phone towers. Results were most strongly negatively correlated to proximity to antennas and Stork recruitment and survival. Twelve nests (40% of his study sample) were located within 200 m of the antennas and never successfully raised any chicks, while only 1 (3.3%), located further than 300 m, never had chicks. Strange behaviors were observed at Stork nesting sites within 100 m of one or several cell tower antennas. Those birds that the main beam impacted directly (i.e., electric field intensity/EFI > 2 V/m) included young that died from unknown causes. Within 100 m, paired adults frequently fought over nest construction sticks and failed to advance the construction of the nests with sticks falling to the ground while nests were being constructed. Balmori (2005) reported that some nests were never completed and the Storks remained passively in front of cellsite antennas. The electric field intensity was higher on nests within 200 m (2.36 ± 0.82 V/m) than on nests further than 300 m (0.53 ± 0.82 V/m). However, the EMF levels, including for nests < 100 m from the antennas, were not intense enough to be classified as thermally active. Power densities need to be at least 10 mW/cm2 to produce tissue heating of even 0.5 C (Bernhardt 1992).

Balmori and Hallberg (2007) and Everaert and Bauwens (2007) found similar strong negative correlations among male House Sparrows and electromagnetic radiation in their studies. In another review, Balmori (2009) reported health effects to birds which were continuously irradiated. They suffered long-term effects including reduced territorial defense posturing, deterioration of bird health, problems with reproduction, and reduction of useful territories due to habitat deterioration.

Beason and Semm (2002) demonstrated that microwave radiation used in cell phones produces non-thermal responses in several types of neurons of the nervous system of Zebra Finches. The brain neurons of anesthetized birds were tested with a 900 MHz carrier, modulated at 217 Hz. Stimulation resulted in changes in the amount of neural activity by more than half of the brain cells with most (76%) of the responding cells increasing their rates of firing by an average 3.5-fold as opposed to controls — a clearly definitive study showing non-thermal effects. The other responding cells exhibited a decrease in their rates of spontaneous activity suggesting potential effects to humans using hand-held cell phones affecting sleep (Borbely et al. 1999). The Beason and Semm (2002) theoretical model could also help explain why birds may be attracted to cell towers, an important theoretical premise that they previously hypothesized in regard to Bobolinks (Semm and Beason 1990).

In a meta-review of studies through 2008, and based on laboratory research they conducted, Panagopoulos and Margaritas (2008) determined maximum radiation distances for both cell phones and for communication towers, based on the Global System for Mobile Telecommunications (GSM) and the Digital Cellular System (DCS). This maximum radiation distance corresponds to an intensity around 10 mW/cm2 for both types of radiation in regards to the RF components — i.e., Bernhardt's (1992) threshold for thermal heating effects. Panagopoulos and Margaritas (2008) recorded an *"intensity window"* — a thermal effect — around 10 mW/cm2 RF exposure where bio-effects became even more severe than at intensities higher than 200 mW/cm2. This *"intensity window"* appeared at a distance of 20-30 cm from the cell phone antenna, corresponding to a distance of about 20-30 meters from a base station antenna. This could be considered a classic nonlinear effect and would apply to far field exposures. Since cell phone base station antennas are frequently located within residential areas where houses and workplaces are often situated at distances 20-30 m from such antennas, not to mention birds nesting and roosting close to these antennas (e.g., Balmori 2005), humans, migratory birds and other wildlife may be exposed up to 24 hours per day.

Based on their research and meta-analyses, Panagopoulos and Margaritas (2008) concluded that large decreases in reproductive capacity were being caused by GSM and DCS radiation fields. This included extensive DNA fragmentation on reproductive cells of experimental animals induced by these fields, exerting an intense biological action able to kill cells, damage DNA, and dramatically decrease the reproductive capacity of living organisms, including populations of wild birds and insects. They cautioned, however, that the physical parameters of these radiations, including intensity, carrier frequency, pulse repetition frequency, distance from the antenna, and similar factors provided inconsistency and lack of standardization making it difficult to correlate specific thermal and non-thermal effects to specific types of radiation. Their take-away message, however, was clear: bio-effects to migratory birds, other wildlife, insects, laboratory animals and humans continue to be documented from thermal and non-thermal exposures, as well as effects from intermediate exposures between the near-field and far-field levels. All migratory birds are potentially at risk, whether they be Bald Eagles, Golden Eagles, Birds of Conservation Concern (USFWS 2008), Federally and/or State-listed bird species, other birds in peril regionally or population-wide, or birds whose populations are stable.

Cucurachi et al. (2013) reported on 113 studies from original peer-reviewed publications and relevant existing reviews. A limited number of ecological studies was identified, the majority of which were conducted in a laboratory setting on bird embryos or eggs, small rodents and plants. In 65% of the studies, ecological effects of RF-EMF (50% of the animal studies and about 75% of the plant studies) were found both at high as well as at low dosages. Lack of standardization and limited sampling made generalizing results from the organism to the ecosystem level very difficult. Cucurachi et al. (2013) concluded, however, that due to the number of variables, no clear dose–effect relationship could be found especially for non-thermal effects. However, effects from some of the studies reviewed were well documented, and certainly can serve as predictors for effects to wild, protected migratory birds and other wildlife in North America.

Engels et al. (2014) investigated *"electromagnetic noise"* emitted everywhere humans use electronic devices including from cell phones and their towers. While prior to their study on European Robins, no *"noise effect"* had been widely accepted as scientifically proven, the authors in this double-blind experiment were able to show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise. The magnetic compass is integral to bird movement and migration. The findings clearly demonstrated a non-thermal effect on European Robins and clearly serves as a predictor for effects to other migratory birds including those in North America.

Levitt and Lai (2010) reported numerous biological effects from cell tower radiation documented at very low intensities comparable to what the population experiences within 60–150 m distance from a cell tower, including effects that occurred in studies of cell cultures and animals after exposures to low-intensity RFR. These reported effects were genetic, growth, and reproductive in nature; they documented increases in permeability of the blood–brain barrier; showed behavioral responses; illustrated molecular, cellular, and metabolic changes; and provided evidence of increases in cancer risk — all applicable to migratory birds, other wildlife and to far field exposures in general. They cited published, peer-reviewed examples of effects that included:

Dutta et al. (1989) who reported an increase in calcium efflux in human neuroblastoma cells after exposure to RFR at 0.005 W/kg. Calcium is an important component in normal cellular functions.

Fesenko et al. (1999) who reported a change in immunological functions in mice after exposure to RFR at a power density of 0.001 mW/cm2. These results can serve as predictors for impacts to wild animals.

Magras and Xenos (1997) who reported a decrease in reproductive function in mice exposed to RFR at power densities of 0.000168— 0.001053 mW/cm2. The results also serve as predictors for reproductive impacts to wildlife.

Forgacs et al. (2006) who reported an increase in serum testosterone levels in rats exposed to GSM-like RFR at specific absorption rates (SAR) of 0.018— 0.025 W/kg. The results also serve as predictors for reproductive impacts to wildlife.

Persson et al. (1997) who reported an increase in the permeability of the blood–brain barrier in mice exposed to RFR at 0.0004– 0.008 W/kg. The blood–brain barrier is a physiological mechanism that protects the brain from toxic substances, bacteria, and viruses. These findings have clear applicability to wildlife including migratory birds.

Phillips et al. (1998) who reported DNA damage in cells exposed to RFR at the SAR of 0.0024– 0.024 W/kg. DNA is integral to the very function and survival of all living organisms, including migratory birds.

Kesari and Behari (2009) also reported an increase in DNA strand breaks in brain cells of rats after exposure to RFR at the SAR of 0.0008 W/kg. The results also serve as predictors for impacts to DNA in wildlife. And,

Belyayev et al. (2009) who reported changes in DNA repair mechanisms after RFR exposure at a SAR of 0.0037 W/kg. DNA is integral to the maintenance and repair of cells and cellular function in all animals. All sources from above were cited in Levitt and Lai (2010).

In a 2-year study conducted by the National Toxicology Program (NTP) of the National Institutes of Health (May 2016), NTP (Wyde 2016) reported partial findings from their $25 million study on cancer risk to laboratory rodents from cellphone radiation. The report summarizes a long-term exposure study to cell phone radiation, with statistically significant evidence of DNA damage from non-thermal exposure to cellphone radiation to laboratory mice and rats. Controlled studies on laboratory rats showed that cellphone radiation caused 2 types of tumors, glioma and schwannoma, the results which *"could have broad implications for public health."* The report has been characterized as a *"game-changer"* as it proves that non-ionizing, radiofrequency radiation can cause cancer without heating tissue. The researchers controlled the temperature of the test animals to prevent heating effects so the cancers were caused by a non-thermal mechanism. The report on the mice component of the study will be released at a later date. Not surprisingly, much of the media coverage contained considerable bias or "media spin" intended to create doubt about the study's important findings regarding cancer risk from exposure to cellphone radiation (Moskowitz 2016). The implications are troubling for migratory birds and other wildlife.

Likely Impacts to Migratory Birds from Frequency Modulated (FM) Signals

FM signals travel in line-of-sight paths, so antennas are located on the highest ground available to blanket an area wherever the target signal recipients are located, also providing convenient perches for migratory birds. FM digital (on/off) signals which simulate pulsed waves pose additional health concerns to migratory birds, especially from thermal heating which will be coupled with the UHF's from cell phone providers often colocated on the same antennas (e.g., see cellphonetaskforce.com; work of Dr. O. Johansson). This creates a very dangerous frequency potential for protected migratory birds such as Bald Eagles since the length of the FM signal is about 6 feet, creating a full-body resonant effect for both humans and Bald Eagles — an Eagle wingspan extends to about 6 feet. Power levels for FM transmission (e.g., 6,000 Watts for a commercial radio station) are far higher than that for a colocated UHF antenna(s), exacerbating thermal heating effects.

Modulated FM signals infuse the atmosphere with lower frequencies which become more bioactive, even at lower power intensities. These, in turn, coupled with a UHF cell phone frequency(s) will create greater thermal and non-thermal effects. Generally the approved level of power for an FM transmission antenna is considerable. The FCC does not measure the modulated signal, only the carrier signal (Levitt 1995). Let's evaluate a hypothetical FM antenna array, with a carrier signal of 104.9 MHz at 47 meters above ground level (AGL), and an effective radiated power of 6,000 Watts. Here, nesting, roosting, feeding and potentially breeding birds such as Bald Eagles using this hypothetical tower would almost certainly be affected by thermal heating, in addition to non-thermal impacts. These issues need to be assessed including through the NEPA review process (either an Environmental Assessment or an Environmental Impact Statement) by FCC and FWS.

The specific absorption rate (SAR) is the energy absorbed per unit of biological tissue, usually expressed in watts per kilogram or milliwatts per gram of tissue, and the SAR is used to focus on *"harmful effects"* to humans. SARs peak in the bands of 70 — 100 MHz (Cleveland 2001). However, as previously mentioned in this memo, there currently are no standards for wildlife exposure to RFR — both from FM and UHF radiation — including for Bald Eagles and all other protected migratory birds. These issues need to be addressed both by FCC and FWS.

Summary Recommendations

Levitt and Lai (2010) concluded that the obvious mechanism of effects from RFR are thermal (i.e., tissue heating) — which is what FCC bases its current radiation standards on, even if they are more than 30 years out of date and rejected both by the Department of Interior and Department of Commerce (USDOI 2014, Manville 2016) as incomplete. However, for decades, there have been questions about non-thermal (i.e., not dependent on a change in temperature) effects, whether they exist, and what specifically causes the effects to surface. The sources cited above should help dispel that doubt or at the very least show that non-thermal effects do indeed occur, have been well documented, and can have significant deleterious effects on migratory birds and other wildlife.

Practically, as Levitt and Lai (2010) concluded, we do not actually need to know whether RFR effects are thermal or non-thermal to set exposure guidelines. Most of the biological-effects studies of RFR that have been conducted since the 1980s were under non-thermal conditions, including the most recent NTP (2016) studies. In studies using isolated cells, the ambient temperature during exposure was generally well controlled. In most animal studies, the RFR intensity used usually did not cause a significant increase in body temperature in the test animals. Most scientists consider non-thermal effects as well established, even though the implications are not fully understood.

Scientifically, Levitt and Lai (2010) concluded that there are three rationales for the existence of non-thermal effects:

1. Effects can occur at low intensities when a significant increase in temperature is not likely.

2. Heating does not produce the same effects as RFR exposure.

3. RFR with different modulations and characteristics produce different effects even though they may produce the same pattern of SAR distribution and tissue heating.

There is virtually no non-thermal research to indicate what is safe for either humans or wildlife, including migratory birds which are highly sensitive to perturbations in ways humans are not (see previous citations). Unfortunately, there also is very little far-field, distance-to-safety research for wildlife — most especially for migratory birds — as this has not been studied with that focus in mind. What little EMF/RF field research on wildlife that has been conducted, its focus has been on behavior, mortality and reproductive outcomes (e.g., B. Levitt and H. Lai, Comments Filed Jointly to FCC, ET Docket No. 13-84, 2013; Balmori 2005, 2009; Balmori and Hallberg 2007; Everaert and Bauwens 2007; Engels et al. 2014; Wasserman et al. 1984; and Semm and Beason 1990).

In summary, we need to better understand, tease out, and refine how to address these growing and poorly understood radiation impacts to migratory birds, bees, bats, and myriad other wildlife. At present, given industry and agency intransigence (with the exception of the Interior Department and Department of Commerce both which are now beginning to address non-thermal radiation issues), massive amounts of money being spent to prevent addressing impacts from non-thermal radiation — not unlike the battles over tobacco and smoking — and a lack of significant, dedicated and reliable funding to advance independent field studies and better understand the etiology and consequences of impacts, we are left with few options. Currently, other than to proceed using the precautionary approach and keep emissions as low as reasonably achievable, we are at loggerheads in advancing meaningful guidelines, policies and regulations that address non-thermal effects. The good news: there appears to be an awakening at least within a significant segment the scientific community to the realization that these issues must be addressed — for the health of humans, wildlife and our environment — and DOI and the Department of Commerce are also beginning to address non-thermal effects to migratory birds.

Next Steps

The following suggestions would help significantly advance the need to address effects/impacts from non-thermal radiation on migratory birds and other wildlife:

- We desperately need to conduct field research on thermal and non-thermal radiation impacts to wild migratory birds and other wildlife here in North America, similar to studies conducted in Europe. Specifically, the research focus should center on causality for *"near-field," "far-field"* and *"intermediate"* effects, ideally based on some standard, agree-upon radiation metrics. The metrics need to be consistent with standards for intensity, carrier frequency, pulse repetition frequency, distance from the antenna, and similar factors. The research must be based on peer-reviewed monitoring and testing protocols (e.g., upgrades to the Manville 2002 peer-reviewed research protocol submitted to the U.S. Forest Service for studies on cell towers in Arizona, and key methodologies used in studies previously referenced in this memo, among others). The research needs to be conducted by credible, independent third party research entities with no vested interest in the outcomes, and the results need to be published in refereed scientific journals, made available to the public.

- Studies need to be designed to better tease out and understand causality of thermal and non-thermal impacts from radiation on migratory birds. Results need to be carefully compared with findings from Europe and elsewhere on wild birds, and efforts need to be made to begin developing exposure guidelines for migratory birds and other wildlife based on dose-effect and other nonlinear relationships. We do not actually need to know whether RFR effects are thermal or non-thermal to develop and set exposure guidelines (Levitt and Lai 2013).

- To minimize deleterious radiation exposures, these guidelines should include use of avoidance measures such as those developed by the electric utility industry for bird collision and electrocution avoidance (APLIC 2006, 2012) — both publications which I co-authored. In the case of Bald Eagles, the communication tower guidelines refined and updated by FWS (Manville 2013) — and submitted to the FCC and industry — recommend one-mile disturbance free buffers during active nesting of Ferruginous Hawks and Bald Eagles, and 0.5-mile buffers around other active raptor nests, based on nest studies conducted by the Wyoming Ecological Services Field Office in that State; Guideline #5). Impacts must address collision mortality, crippling loss, and injury; mortality, injury, population viability and survivorship based on impacts from radiation; as well as disturbance and habitat fragmentation. The updated 2013 Service Guidelines were intended to be inclusive.

- Studies need to be conducted on the use of "faux" branches (i.e., metal arms that mimic pine or fir branches) on cell and/or FM towers intended to disguise the towers as trees, but provide nesting and roosting opportunities for migratory bird including Bald Eagles, which will almost certainly be impacted both by thermal and non-thermal radiation effects. Additionally, birds such as Bald Eagles and others are subject to possible impalement from the sharp metal arms, with enhanced chances of injury and death due to disturbance from tower maintenance. Even if these "faux" branches are not constructed, Eagles for example tend to use the tallest objects available for roosting, so impacts from roosting, feeding and breeding on the antenna supports all must be considered by FCC and FWS.

- Agencies tasked with the protection, management, and research on migratory birds and other wildlife (e.g., FWS, U.S. Geological Survey, National Park Service, U.S. Forest Service, Bureau of Land Management, and USDA Wildlife Services, among others) need to develop radiation policies that avoid or minimize impacts to migratory birds and other trust wildlife species. This means supporting — and where applicable — conducting research, and developing policies that help minimize radiation impacts.

- As Levitt and Lai (2010) concluded, we do not actually need to know whether RFR effects are thermal or non-thermal to set exposure guidelines. Most scientists consider non-thermal effects as well established, even though the implications are not fully understood.

- Given the rapidly growing database of peer-reviewed, published scientific studies (e.g., http://www.saferemr.com, School of Public Health, University of California, Berkeley), it is time that FCC considers thermal and non-thermal effects from EMR in their tower permitting, and incorporates changes into their rulemaking regarding "effects of communication towers on migratory birds."

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Electrohypersensitivity: State-of-the-Art of a Functional Impairment

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Recently, a new category of persons, claiming to suffer from exposure to electromagnetic fields, has been described in the literature. In Sweden, electrohypersensitivity (EHS) is an officially fully recognized functional impairment (i.e., it is not regarded as a disease). Survey studies show that somewhere between 230,000–290,000 Swedish men and women report a variety of symptoms when being in contact with electromagnetic field (EMF) sources. The aim of our studies has been to investigate possible alterations, in the cellular and neuronal systems of these persons' skin. As controls, age- and sex-matched persons, without any subjective or clinical symptoms or dermatological history, served. Immunohistochemistry using antisera to the previously characterized marker substances of interest has been utilized. In summary, it is evident from our preliminary data that various alterations are present in the electrohypersensitive persons' skin. In view of recent epidemiological studies, pointing to a correlation between long-term exposure from power-frequent magnetic fields or microwaves and cancer, our data ought to be taken seriously and further analyzed.

Keywords Dermatoscience; Electrohypersensitivity; Impairment; Immunohistochemistry; Neuroscience.

An ever increasing number of studies has clearly shown various biological effects at the cellular level of electromagnetic fields, including power-frequent and radiofrequent ones as well as microwaves. Such electromagnetic fields are present in your everyday life, at the workplace, in your home, and at places of leisure.

Recently, a new category of persons with a functional impairment (electrohypersensitivity; EHS) has been described in the literature, namely those that claim to suffer from subjective and objective skin- and mucosa-related symptoms, such as itch, smarting, pain, heat sensation, redness, papules, pustles, etc., after exposure to visual display terminals (VDTs), mobile phones, DECT telephones, as well as other

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electromagnetic devices. Frequently, symptoms from internal organ systems, such as the heart and the central nervous system, are also encountered.

Persons claiming such adverse skin reactions after having been exposed to computer screens or mobile phones very well could be reacting in a highly specific way and with a completely correct avoidance reaction, especially if the provocative agent was radiation and/or chemical emissions—just as you would do if you had been exposed to, e.g., sun rays, X-rays, radioactivity, or chemical odors. The working hypothesis, thus, early became that they react in a cellularly correct way to the electromagnetic radiation, maybe in concert with chemical emissions such as plastic components, flame retardants, etc., something later focused upon by professor Denis L. Henshaw and his collaborators at the Bristol University (cf. Fews et al., 1999a,b). This is also covered in great depth by Gunni Nordström in her latest book (2004).

Very soon, however, from different clinical colleagues, and in parallel to the above, a large number of other 'explanations' became fashionable, e.g., that the persons claiming electrohypersensitivity were only imagining this, or they were suffering from post-menopausal psychological abberations, or they were old, or having a short school education, or were the victims of classical Pavlovian conditioning, or a journalist-driven mass media psychosis. Strangely enough, most of the, often self-made, 'experts' who proposed these explanations had themselves never met anyone claiming electrohypersensitivity and these 'experts' had never done any investigations of the proposed explanatory models.

The aim of our own studies has been to investigate possible alterations, in the cellular and neuronal systems of these persons' skin. As controls, age- and sex-matched persons, without any subjective or clinical symptoms or dermatological history, have served. Immunohistochemistry using antisera to the previously characterized marker substances of interest has been utilized. Among many discoveries, the following may be mentioned.

We have investigated the presence of intraepidermal nerve fibers in normal human skin from healthy volunteers using the new marker PGP 9.5 (Hilliges et al., 1995; Johansson et al., 1999; Wang et al., 1990). The intraepidermal nerve fibers are found as close as 20–40 μm from the surface, which makes it highly possible that weak electromagnetic fields may affect them.

In facial skin samples of electrohypersensitive persons, the most common finding is a profound increase of mast cells. Nowadays we do not only use histamine, but also other mast cell markers such as chymase and tryptase, but the pattern is still the same as reported previously for other electrohypersensitive persons (Johansson and Liu, 1995). From these studies, it is clear that the number of mast cells in the upper dermis is increased in the electrohypersensitivity group. A different pattern of mast cell distribution also occurred in the electrohypersensitivity group, namely, the normally empty zone between the dermo-epidermal junction and mid-to-upper dermis disappeared in the electrohypersensitivity group and, instead, this zone had a high density of mast cell infiltration. These cells also seemed to have a tendency to migrate towards the epidermis (=epidermiotrophism) and many of them emptied their granular content (=degranulation) in the dermal papillary layer. Furthermore, more degranulated mast cells could be seen in the dermal reticular layer in the electrohypersensitivity group, especially in those cases which had the mast cell epidermiotrophism phenomenon described above. Finally, in the electrohypersensitivity group, the cytoplasmic granules were more densely distributed and more strongly stained than in the control group, and, generally, the size of the infiltrating mast cells was found to be larger in the electrohypersensitivity group as well. It should be noted that increases of similar nature later on were demonstrated in an experimental situation employing normal healthy volunteers in front of visual display units, including ordinary household television sets (Johansson et al., 2001).

In one of the early papers (Johansson et al., 1994), we made a sensational finding when we exposed two electrically sensitive individuals to a TV monitor. When we looked at their skin under a microscope, we found something that surprised us. In this article, we used an open-field provocation, in front of an ordinary TV set, of persons regarding themselves as suffering from skin problems due to work at video display terminals. Employing immunohistochemistry, in combination with a wide range of antisera directed towards cellular and neurochemical markers, we were able to show a high-to-very high number of somatostatin-immunoreactive dendritic cells as well as histamine-positive mast cells in skin biopsies from the anterior neck taken before the start of the provocation. At the end of the provocation the number of mast cells was unchanged, however, the somatostatin-positive cells had seemingly disappeared. The reason for this latter finding is discussed in terms of loss of immunoreactivity, increase of breakdown, etc. The high number of mast cells present may explain the clinical symptoms of itch, pain, edema, and erythema.

We have compared facial skin from electrohypersensitive persons with corresponding material from normal healthy volunteers (Johansson et al., 1996). The aim of the study was to evaluate possible markers to be used for future double-blind or blind provocation investigations. Differences were found for the biological markers calcitonin gene-related peptide (CGRP), somatostatin (SOM), vasoactive intestinal polypeptide (VIP), peptide histidine isoleucine amide (PHI), neuropeptide tyrosine (NPY), protein S-100 (S-100), neuron-specific enolase (NSE), protein gene product (PGP) 9.5, and phenylethanolamine N-methyltransferase (PNMT). The overall impression in the blind-coded material was such that it turned out easy to blindly separate the two groups from each other. However, no single marker was 100% able to pin-point the difference, although some were quite powerful in doing so (CGRP, SOM, S-100). In our ongoing investigations, we have also found alterations of the Merkel cell number in the facial skin of electrohypersensitive persons (Yoshimura et al., 2006). However, it has to be pointed out that we cannot, based upon those results, draw any definitive conclusions about the cause of the changes observed. Blind or double-blind provocations in a controlled environment (Johansson et al., 2001) are necessary to elucidate the underlying causes for the changes reported in this particular investigation.

I and my collaborator, Dr. Shabnam Gangi, in two papers of theoretical nature (Gangi and Johansson, 1997, 2000), have put forward a model for how mast cells and substances secreted from them (e.g., histamine, heparin, and serotonin) could explain sensitivity to electromagnetic fields. The model bounces off from known facts in the fields of UV- and ionizing irradiation-related damages, and uses all the new papers dealing with alterations seen after, e.g., power-frequent or microwave electromagnetic fields, to propose a simple summarizing model for how we can understand the phenomenon of electrohypersensitivity.

In the first paper (Gangi and Johansson, 1997), we describe the fact that an increasing number of persons say that they get cutaneous problems as well as symptoms from certain internal organs, such as the central nervous system and the heart, when being close to electric equipment. A major group of these persons are the users of video display terminals, who claim to have subjective and objective skin- and mucosa-related symptoms, such as pain, itch, heat sensation, erythema, papules, and pustules. The central nervous system-derived symptoms are, e.g., dizziness, tiredness, and headache. Erythema, itch, heat sensation, edema, and pain are also common symptoms of sunburn (UV dermatitis). Alterations have been observed in cell populations of the skin of electrohypersensitive persons similar to those observed in the skin damaged due to ultraviolet light or ionizing radiation. In electrohypersensitive persons a much higher number of mast cells have been observed. It is known that UVB irradiation induces mast cell degranulation and release of TNF-alpha. The high number of mast cells present in the electrohypersensitivity group and the possible release of specific substances, such as histamine, may explain their clinical symptoms of itch, pain, edema, and erythema. The most remarkable change among cutaneous cells, after exposure with the above-mentioned irradiation sources, is the disappearance of the Langerhans' cells. This change has also been observed in electrohypersensitive persons, again pointing to a common cellular and molecular basis. The results of this literature study demonstrate that highly similar changes exist in the skin of electrohypersensitive persons, as regards the clinical manifestations as well as alterations in the cell populations, and in skin damaged by ultraviolet light or ionizing radiation.

In the second publication (Gangi and Johansson, 2000), the relationship between exposure to electromagnetic fields and human health is even more in focus. This is mainly because of the rapidly increasing use of such electromagnetic fields within our modern society. Exposure to electromagnetic fields has been linked to different cancer forms, e.g., leukemia, brain tumours, neurological diseases, such as Alzheimer's disease, asthma, and allergy, and to the phenomenon of electrohypersensitivity/screen dermatitis. There is an increasing number of reports about cutaneous problems as well as symptoms from internal organs, such as the heart, in people exposed to video display terminals. These people suffer from subjective and objective skin and mucosa-related symptoms, such as itch, heat sensation, pain, erythema, papules, and pustules (cf. above). In severe cases, people cannot, for instance, use video display terminals or artificial light at all, or be close to mobile telephones. Mast cells, when activated, release a spectrum of mediators, among them histamine, which is involved in a variety of biological effects with clinical relevance, e.g., allergic hypersensitivity, itch, edema, local erythema, and many types of dermatoses. From the results of recent studies, it is clear that electromagnetic fields affect the mast cell, and also the dendritic cell, population, and may degranulate these cells. The release of inflammatory substances, such as histamine, from mast cells in the skin results in a local erythema, edema, and sensation of itch and pain, and the release of somatostatin from the dendritic cells may give rise to subjective sensations of ongoing inflammation and sensitivity to ordinary light. These are, as mentioned, the common symptoms reported from persons suffering from electrohypersensitivity/screen dermatitis. Mast cells are also present in the heart tissue and their localization is of particular relevance to their function. Data from studies made on interactions of electromagnetic fields with the cardiac function have demonstrated that highly interesting changes are present in the heart after exposure to electromagnetic fields. Some electrically sensitive people have symptoms similar to heart attacks after exposure to electromagnetic fields.

One could speculate that the cardiac mast cells are responsible for these changes due to degranulation after exposure to electromagnetic fields. However, it is still not known how, and through which mechanisms, all these different cells are affected by electromagnetic fields. In this article (Gangi and Johansson, 2000), we present a theoretical model, based upon the above observations of electromagnetic fields and their cellular effects, to explain the proclaimed sensitivity to electric and/or magnetic fields in humans.

In a recent article by Holmboe and Johansson (2005), the functional impairment electrohypersensitivity was investigated with the aim to characterize the complex set of symptoms and to order them according to the WHO's ICQ10 register of diagnoses. Furthermore, we also tested for the presence of increased levels of IgE or signs of a positive Phadiatop Combi (which is a screening test for allergies towards certain articles of food, pollen, insects, and other animals) which both would be indicators of an immune system alert. If such increases would be found, they could then be used in the diagnosis of electrohypersensitivity.

Twenty-two people (5 men, 17 women) participated. The age range was between 25 and 79 years. The symptoms were given in a ranked scale where the symptoms were attributed points according to the following: $0 =$ no symptoms at all; $1 =$ occasional, mild symptoms; $2 =$ occasional, severe symptoms; $3 =$ regular, mild symptoms; $4 =$ regular, severe symptoms.

Symptoms of the skin and the nervous system dominated the picture. The most frequent ones were skin redness, eczema and sweating, loss of memory, concentration difficulties, sleep disturbances, dizziness as well as muscular and joint-related pain, and muscular and joint-related weakness. Headache, faintness, nose blockade, and fatigue were also common. In addition, 19 of the people had symptoms from the gastrointestinal tract. All the people with the impairment electrohypersensitivity had tinnitus.

No connection between IgE blood levels and symptoms could be found, all the people with electrohypersensitivity had normal values (<122 kU/l). Only 3 people had a positive Phadiatop Combi.

In summary, it is evident from our preliminary experimental data that various biological alterations are present in the electrohypersensitive persons claiming to suffer from exposure to electromagnetic fields. In view of recent epidemiological studies, pointing to a correlation between long-term exposure from power-frequent magnetic fields or microwaves and cancer, our data ought to be taken seriously and further analyzed.

Thus, it is of paramount importance to continue the investigation of persons with the impairment electrohypersensitivity. We would favor studies of electromagnetic fields' interaction with mast cell release of histamine and other biologically active substances, studies of lymphocyte viability, as well as studies of the newly described serotonin-containing melanocytes. Also, continued analysis of the intraepidermal nerve fibers and their relations to these mast cells and serotonin-containing melanocytes are very important. Finally, not to be forgotten, a general investigation—of persons with the impairment electrohypersensitivity versus normal healthy volunteers—regarding the above markers as well as other markers for cell traffic, proliferation, and inflammation, is very much needed. Such scientific work may lay a firm foundation for necessary adjustment of accessibility, thus helping and supporting all persons with the functional impairment electrohypersensitivity.

In addition to the studies in humans, we have also done a series of animal experiments (Rajkovic et al., 2005a,b, 2006). These have been a collaborative effort between the Department of Biology, Faculty of Sciences, Novi Sad, Serbia and Montenegro, and my own research group at the Karolinska Institute, Stockholm, Sweden.

These papers go back to the above-mentioned early observations in people with the impairment electrohypersensitivity where large increases in the cutaneous mast cell count could be demonstrated as compared to normal healthy volunteers. A corresponding effect on cutaneous mast cells from normal healthy volunteers placed in front of ordinary TVs/PCs could also be shown. My working hypothesis since then is that electrohypersensitivity is a kind of irradiation damage, since the observed cellular changes are very much the same as the ones you would find in tissue subjected to UV-light or ionizing radiation (for references, see above).

One very fierce criticism from certain 'opponents' has been that such mast cell alterations in people with electrohypersensitivity (or in normal healthy volunteers) cannot be due to the action of electromagnetic fields (EMFs) and/or airborn chemicals, but must be due to psychological or psychiatric personality disturbances, cognitive malfunction, or likewise.

The aim of these studies has therefore been to investigate the influence of extremely low-frequency electromagnetic fields (ELF-EMFs) on mast cells, parafollicular cells, and nerve fibers in rat skin and thyroid gland, as seen using light and transmission electron microscopy. The experiments were performed on 2-month-old Wistar male rats exposed for 4 h a day, 5 or 7 days a week for 1 month to power-frequent (50 Hz) EMFs (100–300 μT, 54–160 V/m). After sacrifice, samples of skin and thyroid were processed for indirect immunohistochemistry or toluidine blue staining and were then analyzed using the methods of stereology. Antibody markers to serotonin, substance P, calcitonin gene-related peptide (CGRP), and protein gene product 9.5 (PGP) were applied to skin sections and PGP, CGRP, and neuropeptide *Y* (NPY) markers to the thyroid. A significantly increased number of serotonin-positive mast cells in the skin ($p < 0.05$) and NPY-containing nerve fibers in the thyroid ($p < 0.01$) of rats exposed to ELF-EMF was found compared to controls, indicating a direct EMF effect on skin and thyroid vasculature.

After ultrastructural examination, a predominance of microfollicles with less colloid content and dilated blood capillaries was found in the EMF group. Stereological counting showed a statistically significant increase of the volume density of follicular epithelium, interfollicular tissue, and blood capillaries as well as the thyroid activation index, as compared to the controls. The volume density of colloid significantly decreased. Ultrastructural analysis of thyroid follicular cells in the EMF group revealed the frequent finding of several colloid droplets within the same thyrocyte with the occasional presence of large-diameter droplets. Alterations in lysosomes, granular endoplasmic reticulum, and cell nuclei compared to the control group were also observed. Taken together, the results of this study show the stimulative effect of power-frequency EMFs on thyroid gland at both the light microscopic and the ultrastructural level.

The obtained animal results cannot be understood by psychological or psychiatric theories, but are claimed to be due only to the EMF exposure.

In Sweden, electrohypersensitivity (EHS) is an officially fully recognized functional impairment (i.e., it is not regarded as a disease). Survey studies show that somewhere between 230,000–290,000 Swedish men and women report a variety of symtoms when being in contact with electromagnetic field (EMF) sources.

The electrohypersensitive people have their own handicap organization, The Swedish Association for the ElectroSensitive (http://www.feb.se; the website has an English version). This organization is included in the Swedish Disability Federation (Handikappförbundens SamarbetsOrgan; HSO). HSO is the unison voice of the Swedish disability associations towards the government, the parliament, and national authorities, and is a cooperative body that today consists of 43 national disability organizations (where The Swedish Association for the ElectroSensitive is 1 of these 43 organizations) with all together about 500,000 individual members. You can read more on http://www.hso.se (the site has an English short version).

Swedish municipalities, of course, have to follow the UN 22 Standard Rules on the equalization of opportunities for people with disabilities ("Standardregler för att tillförsäkra människor med funktionsnedsättning delaktighet och jämlikhet"; about the UN 22 Standard Rules, see website: http://www.un.org/esa/socdev/enable/dissre00.htm). All people with disabilities shall, thus, be given the assistance and service they have the right to according to the Swedish Act concerning Support and Service for Persons with Certain Functional Impairments (LSS-lagen) and the Swedish Social Services Act (Socialtjänstlagen). People with disabilities, thus, have many different rights and can get different kinds of support. The purpose of those rights and the support is to give every person the chance to live like everyone else. Everyone who lives in the Swedish municipalities should be able to lead a normal life and the municipalities must have correct knowledge and be able to reach the people who need support and service. People with disabilities shall be able to get extra support so that they can live, work, study, or do things they enjoy in their free time. The municipalities are responsible for making sure that everyone gets enough support. Everyone shall show respect and remember that such men and women may need different kinds of support.

In Sweden, impairments are viewed from the point of the environment. No human being is in itself impaired, there are instead shortcomings in the environment that cause the impairment (as the lack of ramps for the person in a wheelchair or rooms electrosanitized for the person with electrohypersensitivity). This environment-related impairment view, furthermore, means that even though one does not have a scientifically based complete explanation for the impairment electrohypersensitivity, and in contrast to disagreements in the scientific society, the person with electrohypersensitivity shall always be met in a respectful way and with all necessary support with the goal to eliminate the impairment. This implies that the person with electrohypersensitivity shall have the opportunity to live and work in an electrosanitized environment.

This view can fully be motivated in relation to the present national and international handicap laws and regulations, including the UN 22 Standard Rules and the Swedish action plan for persons with impairments (prop. 1999/2000:79 "Den nationella handlingplanen för handikappolitiken – Från patient till medborgare"). Also, the Human Rights Act in the EU fully applies.

A person is disabled when the environment contains some sort of impediment. It means that in that moment a man or woman in a wheelchair cannot come onto the bus, a train, or into a restaurant, this person has a disability—he or she is disabled. When the bus, train, or restaurant are adjusted for a wheelchair, the person does not suffer from his disability and is consequently not disabled. An electrohypersensitive person suffers when the environment is not properly adapted according to their personal needs. Strategies to enable a person with this disability to attend common rooms such as libraries, churches, and so on, are, for instance to switch off the high-frequency fluorescent lamps and instead use ordinary light bulbs. Another example is the possibility to switch off—the whole or parts of—the assistive listening systems (persons with electrohypersensitivity are often very sensitive to assistive listening systems).

In the Stockholm municipality—where I live and work as a scientist with the responsibility to investigate comprehensive issues for people with electrohypersensitivity—such persons have the possibility to get their home sanitized for EMFs. This means, for example, that ordinary electricity cables are changed to special cables. Furthermore, the electric stove can be changed to a gas stove and walls, roofs and floors can be covered with special wallpaper or paint with a special shelter to stop EMFs from the outside (from neighbors and mobile telephony base stations). Even the windows can be covered with a thin aluminum foil as an efficient measure to restrain EMFs to get into the room/home. If these alterations turn out not to be optimal they have the possibility to rent small cottages in the countryside that the Stockholm municipality owns. These areas have lower levels of irradiation than others. The Stockholm municipality also intend to build a village with houses that are specially designed for people who are electrohypersensitive. This village will be located in a low-lewel irradiation area. (One of my graduate students, Eva-Rut Lindberg, has in her thesis project studied the "construction of buildings for persons with the impairment electrohypersensitivity". The doctoral thesis will be presented during the spring.)

People with electrohypersensitivity also have a general (legal) right to be supported by their employer so that they can work despite of this impairment. For instance, they can get special equipment such as computers that are of low-emission type, high-frequency fluorescent lamps can be changed to ordinary light bulbs, wireless DECT telephones removed from their rooms, and so on.

Some hospitals in Sweden (e.g., in Umeå, Skellefteå, and Karlskoga) also have built special rooms with very low EMFs so that people who are hypersensitive can get medical care. Another example is the possibility for people who are electrohypersensitive to get a specially designed car so that the person can transport himself/herself between his/her home and their workplace.

Recently, some politicians in the Stockholm municipality even proposed to the politicians responsible for the subway in the Stockholm City that a part of every trainset should be free from mobile phones; that the commuters have to switch of the phones in these selected parts to enable people with electrohypersensitivity to travel with the subway (compare this with people who have an allergy for animal fur whereupon people consequently are prohibited to have animals, such as dogs or cats, in selected parts of the trainset).

In addition, when the impairment electrohypersensitivity is discussed it is also of paramount importance that more general knowledge is needed with the aim to better adapt the society to the specific needs of the persons with this impairment. The Swedish "Miljöbalk" (the Environmental Code) contains an excellent prudence avoidance principle which, of course, must be brought into action also here, together with respect and willingness to listen to the people with electrohypersensitivity.

Naturally, all initiatives for scientific studies of the impairment electrohypersensitivity must be characterized and marked by this respect and willingness to listen, and the investigations shall have the sole aim to help the persons with this particular impairment. Rule 13 in the UN 22 Standard Rules clearly says that scientific investigations of impairments shall, in an unbiased way—and without any prejudice—focus on cause, occurrence and nature and with the sole and explicit purpose to help and support the person with the impairment. Nothing else!

In addition, it must also be mentioned that quite recently, by the end of 2004, The Irish Doctors' Environmental Association (IDEA) has announced that "they have identified a sub-group of the population who are particularly sensitive to exposure to different types of electromagnetic radiation. The safe levels currently advised for exposure to this non-ionising radiation are based solely on its thermal effects. However, it is clear that this radiation also has non-thermal effects, which need to be taken into consideration when setting these safe levels. The electrosensitivity experienced by some people results in a variety of distressing symptoms which must also be taken into account when setting safe levels for exposure to non-ionising radiation and when planning the siting of masts and transmitters" (IDEA, 2004).

Furthermore, the IDEA also points out the following:

1. An increasing number of people in Ireland are complaining of symptoms which, while they may vary in nature, intensity, and duration, can be demonstrated to be clearly related to exposure to electro-magnetic radiation (EMR).

2. International studies on animals over the last 30 years have shown the potentially harmful effects of exposure to electro-magnetic radiation. In observational studies, animals have shown consistent distress when exposed to EMR. Experiments on tissue cultures and rats have shown an increase in malignancies when exposed to mobile telephone radiation.

3. Studies on mobile telephone users have shown significant levels of discomfort in certain individuals following extensive use or even, in some cases, following regular short-term use.

4. The current safe levels for exposure to microwave radiation were determined based solely on the thermal effects of this radiation. There is now a large body of evidence that clearly shows that this is not appropriate, as many of the effects of this type of radiation are not related to these thermal effects (IDEA, 2004).

Finally, The IDEA "believes that the Irish Government should urgently review the information currently available internationally on the topic of the thermal and non-thermal effects of exposure to electro-magnetic radiation with a view to immediately initiating appropriate research into the adverse health effects of exposure to all forms of non-ionising radiation in this country, and into the forms of treatment available elsewhere. Before the results of this research are available, an epidemiological database should be initiated of individuals suffering from symptoms thought to be related to exposure to non-ionising radiation. Those claiming to be suffering from the effects of exposure to electro-magnetic radiation should have their claims investigated in a sensitive and thorough way, and appropriate treatment provided by the State. The strictest possible safety regulations should be established for the installation of masts and transmitters, and for the acceptable levels of potential exposure of individuals to electro-magnetic radiation, in line with the standards observed in New Zealand." (IDEA, 2004). Of course, these very recent findings must also be taken into serious consideration for any research proposal.

It may also be noted that a unique conference recently was held in Stockholm in May, 2006. The theme for the conference was "The right for persons with the impairment electrohypersensitivity to live in a fully accessible society". The conference was organized by the Stockholm City municipality and the Stockholm County Council and dealt with the most recent measures to make Stockholm fully accessible for persons with the impairment electrohypersensitivity. Among such measures are to offer home equipment adjustments and ban mobile phones from certain underground cars as well as certain public bus seats, and through electrosanitized hospital wards. The conference was documented on film.

The effects of various forms of electromagnetic fields are also discussed within areas of medicine, such as cancer. Cancer is, unfortunately, spreading in the modern society. Nearly all cancer forms are increasing when it comes to incidence, i.e., new cases/year (cf. Hallberg and Johansson, 2002a). It could recently be read in the BBC News that skin cancer is rising in young adults, and Sara Hiom, head of the health information at Cancer Research UK said, when interviewed, that "Non-melanoma cancers are rising at an alarming rate".

More and more research efforts goes into understanding the molecular mechanisms behind these various progressive cancer forms, and much more money is spent on finding new drugs to treat patients. However, oddly enough, very little is spent on understanding the actual causes for cancer. Among such possible causative agents, more and more focus is nowadays put on modern gadgets, such as mobile telephones and computers, and their chemical and physical emissions, including flame retardants and electromagnetic non-ionizing radiation.

Childhood leukemia was early connected to power-frequent magnetic fields already in the pioneering work by Wertheimer and Leeper (1979), and more recently, Scandinavian scientists have identified an increased risk for acoustic neuroma (i.e., a benign tumor of the eighth cranial nerve) in cell phone users, as well as a slightly increased risk of malignant brain tumors such as astrocytoma and meningioma on the same side of the brain as the cell phone was habitually held (Hardell et al., 1999, 2004, 2005; Lonn et al., 2004). In addition, a clear association between adult cancers and FM radio broadcasting radiation has been noticed, both in time and location (Hallberg and Johansson, 2002b, 2004a, 2005a). Initial studies on facial nevi indicates that nowadays young children also can have a substantial amount of these. If it can be shown that radiofrequent radiation is not correlated with child cancers, the current focus on low-frequency electromagnetic fields can continue. If there is also a radiofrequent and/or microwave correlation, then this must be considered in future research as well as in today's preventive work.

Most recently, Dr. Djemal Beniashvili and other scientists at the Edith Wolfson Medical Center in Holon, Israel, have demonstrated a possible link between exposure to power-frequent electromagnetic fields and breast cancer in elderly women (Beniashvili et al., 2005). They compared the breast cancer rates in elderly women from an earlier period (1978–1990) to a more recent period (1991–2003), which has been characterized by a much more extensive use of personal computers (more than three hours a day), mobile telephones, TV sets, and other household electrical appliances. They used available medical records extending over a period of 26 years, involving the analysis of more than 200,000 samples.

Among the elderly women who developed breast cancer in the first time frame, 20% were regularly exposed to power-frequent fields. But in the more modern period, 51% were so exposed, mainly through the use of personal computers. The authors concluded: "There was a statistically significant influence of electromagnetic fields on the formation of all observed epithelial mammary tumours in the second group." This represented a more than two-fold increase, which was considered highly significant (cf. Beniashvili et al., 2005).

Of course, many other environmental factors have changed during the period 1978–1990, but increased environmental exposure to power-frequent fields is among the more conspicuous changes to have taken place. Naturally, there are many aspects of this question that remain to be clarified, and, from a scientific point of view, it is far from conclusively settled.

During the second half of the 20th century an increasing rate of lung cancer was noticed in Sweden. Since the mid-1960's, tobacco smoking has been associated with this cancer and believed to be the main cause. Less noticed, though, is the fact that no connection between smoking and lung cancer was noticed before 1955. Together with my co-worker Örjan Hallberg, we have therefore initiated a project with the intention to review facts that may shed new light on this sudden increase in getting lung cancer after 1955 in Sweden.

A large number of scientific reports point at tobacco smoking as being the main cause of the increasing rate of lung cancer in the world. These reports have mainly been produced during the second half of the 20th century. The Swedish National Board of Health and Welfare ("Socialstyrelsen") states that 80–90% of the lung cancer deaths are caused by smoking. The main part of the victims are also smokers. About 10% of the lung cancer deaths have been non-smokers. This has led to the suspicion that also passive smoking can cause lung cancer. Other environmental factors such as radon and asbestos are believed to cause a number of lung cancer deaths per year, and especially if combined with smoking.

As pointed out above, Hallberg and Johansson have earlier reported about a strong association between body-resonant non-ionizing radiation (FM-radio, 100 MHz) and the existence of malignant melanoma of the skin (Hallberg and Johansson, 2002b, 2004a, 2005a). Since this frequency range has a penetration depth of about 10 cm into the human body, there is a suspicion that resonant currents may affect the immune defense system also when it comes to beating cancer cells in the lungs. Due to that it is well motivated to study in detail how the presence and rate of lung cancer have changed in Sweden, and in other countries, as this new environmental factor was added.

In a yet unpublished report (Hallberg and Johansson, 2006), we have shown how the rate of lung cancer can accelerate in connection with a sudden exposure of a population to such body-resonant radiation. From this work, it can be noticed that people who have been smoking for many years suddenly could get lung cancer relatively short after the introduction of the FM-radio. This abrupt increase was not noticed in counties where the FM-radio still was not rolled out. It is also noticeable that deaths due to asbestosis have not been known until after the 1960's despite the fact that asbestos has been used as a building material since the end of the 19th century. In our work it is also shown how weak the connection is between lung cancer and cigarette consumption in a number of countries. But if the lung cancer mortality is normalized to the melanoma of skin mortality in the same countries, all of a sudden a very strong correlation appears. This indicates that there is a common factor behind the fast increasing mortality of skin and lung cancer that we have noticed, e.g., in Sweden.

An automated computer analysis of the age-specific incidence of lung cancer among men in Sweden points at year 1955 as the starting year for a sudden environmental change in Sweden and that this disturbance mainly affects men over 60 years of age. This method of analysis has successfully been applied to study the development of melanoma of skin in Sweden, Norway, Denmark, Finland, and the U.S.

Authorities responsible for the health of the general population should have a big interest in causative factors behind such major cancer types. Doctors and specialists should know more about the real causes behind lung cancer. Epidemiologists in general might get inspired to test new methods and to look at population health problems from a new perspective. Only the future, however, will know the answer to these medical hypotheses.

Finally, as already mentioned, one issue that is very much addressed in the public as well as in the scientific literature is the question about the effect(s) of mobile phone radiation on health. Ten years of intensively increasing mobile phone usage have passed. According to some, it has facilitated our lifestyle, but more and more people are nowadays concerned about the lack of knowledge regarding the effects of radiation on health. For instance, it may be noted that mobile and DECT telephones are among the worst sources of problems for electrohypersensitive persons. In addition, it is now a well-known and fully accepted fact that mobile phone usage causes injuries in traffic and during work.

Mobile telephony-related risks may be divided between effects of radiation (microwaves, low-frequency magnetic fields) from the hand-held mobile telephone and radiation (microwaves) from remote base stations mounted on roofs, walls, towers, masts, etc.

Extensive laboratory research on animals, mainly rats, has not revealed premature death, increased cancer risk, or general sickness. However, very little can be drawn from this since rats and other laboratory animals have a maximal life span of approximately two years. The human cancer data point, instead, on an exposure time needed of at least five years, thus data from rats will not be of any real use. In addition, other biologic or metabolic parameters, as well as molecular biology and genetic data, are missing.

Epidemiological research with human case-control methodology suggests an increased risk for highly malignant brain lesions and acoustic neuromas after extended use (>5 years; Hardell et al., 1999, 2004, 2005; Lonn et al., 2004), but additional confirmation is needed. The present epidemiological surveillance thus indicates an increased risk for cancer in humans but observation times are too short. Ecological studies, in addition, suggest an increased general health degradation in areas of high average output power from the hand-held mobile phones (Hallberg and Johansson, 2004b,c,d, 2005b).

There is still insufficient contemporary proof with regard to increased cancer risk to change adult mobile phone usage. However, signs of degrading general health in sparsely populated areas suggest that the use of mobile phones at high output power levels should be avoided. Therefore, it is now of paramount importance that epidemiological research should be supplemented with prospective studies and quality exposure data (standardization). Continuous surveillance is also needed. In the meantime, children and adolescents should definitely be discouraged to use mobile phones.

It is a must that fully financied, truly independent research projects immediately should be initiated to ascertain the public health. They shall be completely devoid of commercial interests of any sort. This is the responsibility of each elected government in each country, and is of special importance for people with the functional impairment electrohypersensitivity.

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BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

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BioInitiative Report: Medical concerns intensify over deadly brain tumors from cell phone use/Orebro University Hospital, Sweden
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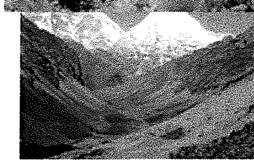
Comment to the FCC on Docket 16-421 on Streamlining for Small Cell (Antenna) Rollout By Relaxing the Rules for Siting
February 1, 2017



The BioInitiative 2012 Report has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS.

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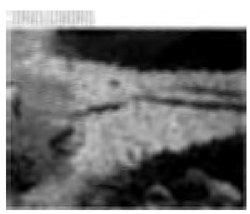

Bioeffects are clearly established to occur with very low exposure levels (non-thermal levels) to electromagnetic fields and radiofrequency radiation exposures.

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Reported Biological Effects

Henry Lai's Research Summaries

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These are invaluable sets of abstracts (data-based to be searchable) covering the RFR scientific literature, as well as collections of scientific abstracts on oxidative effects (from both RFR and ELF), and a set specific to Electrosensitivity. New comet assay abstracts for RFR and ELF are added in 2017.

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Wednesday, October 25, 2017

Scientists and Doctors Demand Moratorium on 5G

The European Commission responds with denial and empty promises to scientists and doctors demanding a moratorium on 5G.

On October 12, the European Commission (EC) issued its **response** to a September 13 **declaration** that demands a moratorium on planned 5G expansion, the fifth generation of mobile communication technology. To date, the declaration has been signed by over 180 scientists and doctors from 35 nations.

The Commission's response contradicts the basic assertion of the declaration. The EC claims that current limits on electromagnetic field (EMF) exposure established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are adequate to protect the population, and that these limits apply to the frequencies to be deployed for 5G.

Signers of the declaration argue that these limits were designed to protect the population from the effects of heating attributable to brief EMF exposures but were not intended to protect people from chronic exposure to low intensity EMF.

The declaration cites language from the 2015 **International EMF Scientist Appeal** which has now been signed by more than 230 scientists who have published peer-reviewed research on EMF and biology or health. Prior to the current controversy about 5G, these experts reported "serious concerns" regarding the ubiquitous and increasing exposure to EMF. Their appeal refers to numerous scientific publications which have shown that EMF "affects living organisms **at levels well below most international and national guidelines.**" These effects include increased cancer risk, neurological disorders, and reproductive harm. The Appeal calls for the strengthening of EMF guidelines and regulatory standards.

In addition, the September declaration cites the International Agency for Research on Cancer's classification of radio frequency radiation as "possibly carcinogenic" in 2011; recommendations of the 2015 Brussels Congress on multiple chemical sensitivity and electromagnetic hypersensitivity; results from the U.S. National Toxicology Program study in 2016 finding cell phone radiation causes DNA damage and cancer in rats; and the Europa EM-EMF 2016 Guideline that long-term EMF exposure is a risk factor for chronic disease and infertility.

The declaration for a 5G moratorium argues that ...

> "current ICNIRP 'safety guidelines' are obsolete. All proofs of harm mentioned above arise although the radiation is below the ICNIRP safety guidelines. Therefore new safety standards are necessary. The reason for the misleading guidelines is that conflict of interest of ICNIRP members due to their relationships with telecommunications or electric companies undermine the impartiality that should govern the regulation of Public Exposure Standards for non-ionizing radiation...."

The EC claims that it "is not aware of any conflicts of interests of members of international bodies such as ICNIRP...."

The EC maintains that "Digital technologies and mobile communication technologies, including high speed internet, will be the backbone of Europe's future economy."

The EC letter acknowledges that citizens deserve appropriate protection against EMF from wireless devices, and concludes with the following empty promise,

> "Please be assured that the Commission will pursue scrutiny of the independent scientific evidence available to ensure the highest health protection of our citizens."

The EC response letter was sent electronically to the authors of the declaration, Professors Rainer Nyberg and Lennart Hardell. The letter was signed by John F. Ryan, the director of public health, country knowledge, crisis management in the EC Directorate—General Health and Food Safety.

September 13, 2017

Increased radiation from cell towers poses potential risks, say scientists from around the world.

(Örebro, Sweden) Over 180 scientists and doctors from 35 countries sent a **declaration** to officials of the European Commission today demanding a moratorium on the increase of cell antennas for planned 5G expansion. Concerns over health effects from higher radiation exposure include potential neurological impacts, infertility, and cancer.

"The wireless industry is trying to deploy technology that may have some very real unintended harmful consequences," explains one of the organizers of the letter, **Lennart Hardell, MD, PhD**, Associate Professor, Department of Oncology, Faculty of Medicine and Health, Örebro University, Örebro, Sweden. "Scientific studies from years ago along with many new studies are consistently identifying harmful human health impacts when wireless products are tested properly using conditions that reflect actual exposures. With hazards at those exposures, we are very concerned that the added exposure to 5G radiation could result in tragic, irreversible harm."

Joel M. Moskowitz, Ph.D.
Director
Center for Family and Community He
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety

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5G expansion, which is designed to carry higher loads of data more rapidly through wireless transmission, will require the construction of cell towers every 10-20 houses in urban areas.

In their letter to the European Commission, the scientists write:

> "We, the undersigned, more than 180 scientists and doctors from 35 nations, recommend a moratorium on the roll-out of the fifth generation, 5G, for telecommunication until potential hazards for human health and the environment have been fully investigated by scientists independent from industry."

University of California, Berkeley public health researcher **Joel Moskowitz, PhD,** explains:

> "Peer-reviewed research has documented industry influence on studies of the health impacts of wireless radiation. We are insisting on a moratorium on 5G until non-industry research can be conducted to ensure the safety of the public."

Moskowitz is one of the advisors to an earlier effort, the **International EMF Scientist Appeal**, a petition submitted to the United Nations and World Health Organization in 2015. The Appeal has now been signed by more than 230 scientists from 41 nations—all have published peer-reviewed research on the biologic or health effects of electromagnetic fields (EMF).

Since the Appeal was published, the world's largest $25 million study, conducted by the **National Toxicology Program** in the US, shows statistically significant increases in the incidence of brain and heart cancer in animals exposed to cellphone radiation at levels below international guidelines. This supports human studies on cellphone radiation and brain tumour risk, as demonstrated in **many peer-reviewed scientific studies.**

The Appeal and this week's declaration identify health concerns from exposure to radiofrequency radiation including ...

> " ... increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life."

Roll-out of 5G in the US

In the US, the wireless industry is promoting legislation in at least 20 states to facilitate the roll-out of 5G in addition to sponsoring legislation at the federal level.

In California, city and county governments are opposing **SB 649**,an industry-sponsored bill which overrides local control over the wireless industry's access to utility poles and public buildings for 5G deployment. Environmental health advocates fear that exposure to the added radiation from 5G infrastructure will contribute to increased health problems.

"If this bill passes, many people will suffer greatly, and needlessly, as a direct result. This sounds like hyperbole. It is not." according to **Beatrice Golomb, MD, PhD**, Professor of Medicine in the medical school at the University of California, San Diego. In her **open letter** which summarizes the research on the effects of radio frequency radiation, she concludes, "Let our focus be on safer, wired and well shielded technology – not more wireless."

The declaration and list of signatories can be found here:
http://bit.ly/5Gappeal170913a

Media Inquiries:

Finland: Rainer Nyberg, EdD
Sweden: Lennart Hardell, MD, PhD
UK: Alasdair Philips, BSc, DAgE, MIEEE
USA: Joel Moskowitz, PhD
USA: Beatrice Golomb, MD, PhD

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5G Wireless Technology: Major newspaper editorials oppose "small cell" antenna bills

Industry-funded Scientists Undermine Cell Phone Radiation Science
Government Failure to Address Wireless Radiation Risks
FCC Open Letter: Moratorium on New Commercial Applications of RF Radiation
An Exposé of the FCC: An Agency Captured by the Industries it Regulates
WHO Radiofrequency Radiation Policy

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Labels: 5G, 5G moratorium, 5th generation, appeal, declaration, EU, Golomb, Hardell, Orebro, roll-out, SB 649, scientist declaration, small cell

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PC Rcvd 01-18-18 to 01-25-18

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Sunday, November 12, 2017

An Exposé of the FCC: An Agency Captured by the Industries it Regulates

Click on graphic to enlarge. Posted with permission of Einar Flydal.

The Corporate Takeover of the Trump-FCC Is in Full Attack Mode

Bruce Kushnick, HuffPost, Nov 9, 2017 (Part 1 of 2)

https://www.huffingtonpost.com/entry/the-corporate-takeover-of-the-trump-fcc-is-in-full_us_5a041fb3e4b055de8d096ab0

The Trump-FCC-AT&T-Et Al. Plan: The Insidious "Wheel of Mis-Fortune"

Bruce Kushnick, HuffPost, Nov 10, 2017 (Part 2 of 2)

https://www.huffingtonpost.com/entry/the-trump-fcc-att-et-al-plan-the-insidious-wheel_us_5a055a13e4b0ee8ec3694081

Bruce Kushnick is the Executive Director of New Networks Institute (NNI), which was established in 1992, and a founding member of the IRREGULATORS, and has been a telecommunications analyst and visionary for over 35 years. During his career he has predicted that the addition of new technologies and networks would change the way we used the phone networks and he helped launch numerous interactive information markets and services that have now become commonplace. http://newnetworks.com/about-bruce-kushnick/

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June 26, 2015

Captured agency: How the Federal Communications Commission is dominated by the industries it presumably regulates

Alster, Norm. ***Captured agency: How the Federal Communications Commission is dominated by the industries it presumably regulates.*** Cambridge, MA: Edmund J. Safra Center for Ethics, Harvard University. 2015.

PDF: http://bit.ly/FCCcaptured (free)
Kindle: http://amzn.to/1SQThCU ($0.99 -- check out the book reviews)
FCC filing: http://bit.ly/FCCcapturedagency

Introduction

This exposé provides insight into how the FCC became a victim of regulatory capture by industry and the implications of these corrupting influences for our health and safety, our privacy, and our wallets.

This book concludes with a series of recommendations by its author, Norm Alster, an investigative journalist, who has written for the *New York Times*, *Forbes*, *Business Week*, and *Investor's Business Daily*. He wrote this book while serving as a journalism fellow with the Investigative Journalism Project at Harvard University.

Following are some excerpts that pertain to the wireless radiation industry and its corrupting influences on the FCC. I encourage you to read Mr. Alster's entire treatise.

Joel M. Moskowitz, Ph.D.
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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Excerpts

A detailed look at FCC actions—and non-actions—shows that over the years the FCC has granted the wireless industry pretty much what it has wanted.

Money—and lots of it—has played a part ... In all, CTIA, Verizon, AT&T, T-Mobile USA, and Sprint spent roughly $45 million lobbying in 2013. Overall, the Communications/Electronics sector is one of Washington's super heavyweight lobbyists, spending nearly $800 million in 2013-2014, according to CRP data.

As a result, consumer safety, health, and privacy, along with consumer wallets, have all been overlooked, sacrificed, or raided due to unchecked industry influence .... Most insidious of all, the wireless industry has been allowed to grow unchecked and virtually unregulated, with fundamental questions on public health impact routinely ignored. Industry control, in the case of wireless health issues, extends beyond Congress and regulators to basic scientific research. And in an obvious echo of the hardball tactics of the tobacco industry, the wireless industry has backed up its economic and political power by stonewalling on public relations and bullying potential threats into submission with its huge standing army of lawyers. In this way, a coddled wireless industry intimidated and silenced the City of San Francisco, while running roughshod over local opponents of its expansionary infrastructure.

... Currently presiding over the FCC is Tom Wheeler, a man who has led the two most powerful industry lobbying groups: CTIA and NCTA. It is Wheeler who once supervised a $25 million industry-funded research effort on wireless health effects. But when handpicked research leader George Carlo concluded that wireless radiation did raise the risk of brain tumors, Wheeler's CTIA allegedly rushed to muffle the message. "You do the science. I'll take care of the politics," Carlo recalls Wheeler saying.

Graphic: The revolving door between the FCC and industry

Tom Wheeler, former Head of CTIA & NCTA, is now FCC Chair.
Meredith Atwell Baker, former FCC Commissioner, is now head of CTIA.
Michael Powell, former FCC Chair, is now head of NCTA.
Jonathan Adelstein, former FCC Commissioner, is now head of PCIA, the Wireless Infrastructure Association.

Graphics: Top House and Senate recipients of cellular industry campaign contributions

It all begins with passage of the Telecommunications Act of 1996, legislation once described ... as "the most lobbied bill in history." Late lobbying won the wireless industry enormous concessions from lawmakers, many of them major recipients of industry hard and soft dollar contributions. Congressional staffers who helped lobbyists write the new law did not go unrewarded. Thirteen of fifteen staffers later became lobbyists themselves.

In preempting local zoning authority—along with the public's right to guard its own safety and health—Congress unleashed an orgy of infrastructure build-out. Emboldened by the government green light and the vast consumer appetite for wireless technology, industry has had a free hand in installing more than 300,000 sites. Church steeples, schoolyards, school rooftops, even trees can house these facilities.

In a 2010 review of research on the biological effects of exposure to radiation from cell tower base stations, B. Blake Levitt and Henry Lai found that "some research does exist to warrant caution in infrastructure siting" ....

Beyond epidemiological studies, research on a wide range of living things raises further red flags. A 2013 study by the Indian scientists S. Sivani and D. Sudarsanam reports: "Based on current available literature, it is justified to conclude that RF-EMF [electromagnetic fields] radiation exposure can change neurotransmitter functions, blood-brain barrier, morphology, electrophysiology, cellular metabolism, calcium efflux, and gene and protein expression in certain types of cells even at lower intensities."

... Citing other studies—often industry-funded—that fail to establish health effects, the wireless industry has dismissed such concerns. The FCC has typically echoed that position.

... since the passage of the 1996 law, the very opposite has occurred. Again and again both Congress and the FCC have opted to stiffen—rather than loosen—federal preemption over local zoning authority ....

... would consumers' embrace of cell phones and Wi-Fi be quite so ardent if the wireless industry, enabled by its Washington errand boys, hadn't so consistently stonewalled on evidence and substituted legal intimidation for honest inquiry?

The FCC in 1997 sent the message it has implicitly endorsed and conveyed ever since: study health effects all you want. It doesn't matter what you find. The build-out of wireless cannot be blocked or slowed by health issues.

... federal preemption is granted to pretty much any wireless outfit on just one simple condition: its installations must comply with FCC radiation emission standards. In view of this generous carte blanche to move radiation equipment into neighborhoods, schoolyards and home rooftops, one would think the FCC would at the very least diligently enforce its own emission standards. But that does not appear to be the case.

Indeed, one RF engineer who has worked on more than 3,000 rooftop sites found vast evidence of non-compliance. Marvin Wessel estimates that "10 to 20% exceed allowed radiation standards." With 30,000 rooftop antenna sites across the U.S. that would mean that as many as 6,000 are emitting radiation in violation of FCC standards. Often, these emissions can be 600% or more of allowed exposure levels, according to Wessel.

The best ally of industry and the FCC on this (and other) issues may be public ignorance.

An online poll conducted for this project asked 202 respondents to rate the likelihood of a series of statements ... there was one statement of indisputable fact: "The U.S. Congress forbids local communities from considering health effects when deciding whether to issue zoning permits for wireless antennae," the statement said.

Though this is a stone cold fact that the wireless industry, the FCC and the courts have all turned into hard and inescapable reality for local authorities, just 1.5% of all poll respondents replied that it was "definitely true."

... many respondents claim they would change behavior—reduce wireless use, restore landline service, protect their children —if claims on health dangers of wireless are true.

... in May 2015, more than 200 scientists boasting over 2,000 publications on wireless effects called on global institutions to address the health risks posed by this technology.

Some have suggested that the health situation with wireless is analogous to that of tobacco before court decisions finally forced Big Tobacco to admit guilt and pay up.

It seems significant that the responses of wireless and its captured agency—the FCC—feature the same obtuse refusal to examine the evidence. The wireless industry reaction features stonewalling public relations and hyper aggressive legal action. It can also involve undermining the credibility and cutting off the funding for researchers who do not endorse cellular safety. It is these hardball tactics that look a lot like 20th century Big Tobacco tactics. It is these hardball tactics—along with consistently supportive FCC policies—that heighten suspicion the wireless industry does indeed have something to hide.

So how does the FCC handle a scientific split that seems to suggest bias in industry-sponsored research?

In a posting on its Web site that reads like it was written by wireless lobbyists, the FCC chooses strikingly patronizing language to slight and trivialize the many scientists and health and safety experts who've found cause for concern. In a two page Web post titled "Wireless Devices and Health Concerns," the FCC four times refers to either "some health and safety interest groups," "some parties," or "some consumers" before in each case rebutting their presumably groundless concerns about wireless risk. Additionally, the FCC site references the World Health Organization as among those organizations who've found that "the weight of scientific evidence" has not linked exposure to radiofrequency from mobile devices with "any known health problems."

Yes, it's true that the World Health organization remains bitterly divided on the subject. But it's also true that a 30 member unit of the WHO called the International Agency for Research on Cancer (IARC) was near unanimous in pronouncing cell phones "possibly carcinogenic" in 2011. How can the FCC omit any reference to such a pronouncement? Even if it finds reason to side with pro-industry scientists, shouldn't this government agency also mention that cell phones are currently in the same potential carcinogen class as lead paint?

Cell phones are not the only wireless suspects. Asked what he would do if he had policy-making authority, Dr. Hardell swiftly replied that he would "ban wireless use in schools and pre-schools. You don't need Wi-Fi," he noted.

So what is the FCC doing in response to what at the very least is a troubling chain of clues to cellular danger? As it has done with wireless infrastructure, the FCC has to this point largely relied on industry "self-regulation." Though it set standards for device radiation emissions back in 1996, the agency doesn't generally test devices itself. Despite its responsibility for the safety of cell phones, the FCC relies on manufacturers' good-faith efforts to test them. Critics contend that this has allowed manufacturers undue latitude in testing their devices.

The EPA, notably, was once a hub of research on RF effects, employing as many as 35 scientists. However, the research program was cut off in the late 80s during the Regan presidency. [Former EPA Scientist, Carl] Blackman says he was personally "forbidden" to study health effects by his "supervisory structure."

Blackman is cautious in imputing motives to the high government officials who wanted his work at EPA stopped. But he does say that political pressure has been a factor at both the EPA and FCC: "The FCC people were quite responsive to the biological point of view. But there are also pressures on the FCC from industry." The FCC, he suggests, may not just be looking at the scientific evidence, "The FCC's position—like the EPA's—is influenced by political considerations as well."

Still, the FCC has ultimate regulatory responsibility and cannot indefinitely pass the buck on an issue of fundamental public health. Remarkably, it has not changed course despite the IARC classification of cell phones as possibly carcinogenic, despite the recent studies showing triple the glioma risk for heavy users, despite the floodtide of research showing biological effects, and despite even the recent defection of core industry booster Alex Lerchl. It is the refusal of both industry and the FCC to even acknowledge this cascade of warning signs that seems most incriminating.

This is a very rich industry that does not hesitate to outspend and bully challengers into submission. Meanwhile, amidst the legal smoke and medical confusion, the industry has managed to make the entire world dependent on its products. Even tobacco never had so many hooked users.

Such sustained success in the face of medical doubt has required industry to keep a lid on critics and detractors. Many scientists who've found real or potential risk from the sort of microwave radiation emanating from wireless devices have learned there is a price to be paid for standing up to the industry juggernaut. A few prominent examples ...

The FCC's network of corruption doesn't just shield industry from needed scrutiny and regulation on matters of public health and safety. Sometimes it just puts its hand directly into the public pocket and redistributes that cash to industry supplicants ...

The General Accounting Office (GAO) has issued several reports citing fraud, waste and mismanagement, along with inadequate FCC oversight of the subsidy program. Bribery, kickbacks and false documentation can perhaps be expected in a handout program mandated by Congress and only indirectly supervised by the FCC.

[The "subsidy program," the Universal Service Fund, subsidizes various technology programs at public cost.]

Fraud—as pervasive and troubling as it has been—is just one of the problems with the programs of universal service. It may not even be the fundamental problem. More fundamental issues concern the very aim, logic and efficiency of programs to extend broadband and wireless technology at public expense. Though the aims of extending service to distant impoverished areas seem worthy on the surface, there are many reasons to think the major beneficiaries of these programs are the technology companies that win the contracts.

... the FCC, prodded by an industry ever on the lookout for incremental growth opportunities, is ignoring the health of youngsters to promote expanded Wi-Fi subsidies in schools across the U.S.

As a captured agency, the FCC is a prime example of institutional corruption. Officials in such institutions do not need to receive envelopes bulging with cash. But even their most well-intentioned efforts are often overwhelmed by a system that favors powerful private influences, typically at the expense of public interest.

... the auctions of electromagnetic spectrum, used by all wireless communications companies to send their signals, have yielded nearly $100 billion in recent years. The most recent auction to wireless providers produced the unexpectedly high total of $43 billion. No matter that the sale of spectrum is contributing to a pea soup of electromagnetic "smog" whose health consequences are largely unknown. The government needs money and Congress shows its appreciation with consistently pro-wireless policies.

Science is often the catalyst for meaningful regulation. But what happens when scientists are dependent on industry for research funding? Under pressure from budget cutters and deregulators, government funding for research on RF health effects has dried up. The EPA, which once had 35 investigators in the area, has long since abandoned its efforts.85 Numerous scientists have told me there's simply no independent research funding in the U.S. They are left with a simple choice: work on industry-sponsored research or abandon the field.

... an FCC with public interest commissioners is an idea worth consideration. It would at least require party apologists to defend how they so consistently champion the moneyed interests that have purchased disproportionate access and power in Washington.

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Labels: cancer, cell phone tower, ctia, FCC, Federal Communications Commission, health effects, legislation, lobbying, money, preemption, regulatory capture, Telecom Act, wifi schools, wireless

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18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

CELL TOWER REPORT

Angela Flynn, Public Health Advocate,
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Revised 11/16/2011

CELL TOWERS AND WIRELESS COMMUNICATIONS – LIVING WITH RADIOFREQUENCY RADIATION

INTRODUCTION

This report is on the topic of cell towers and the possible ill health effects from exposure to the transmitting antennas for our wireless communications. These antennas are found on all wireless communications devices, such as cell towers, WiMax systems, internet routers*, cell and cordless phones (DECT), smart meters* and smart boards*, ebook readers and baby monitors.

The information in my report is mostly limited to cell towers (also called masts and base stations). Towers, masts and base stations are not the issue in them selves. It is the transmitting antennas that are indicated in ill health effects. These antennas all have electromagnetic fields and emit radiofrequency radiation (EMF/RFR) part of the non ionizing radiation (NIR) on the electromagnetic spectrum.

Transmitting antennas may also be found on buildings and utility poles. The terms wireless communications devices and wireless telecommunications facilities are also used. My report will use many of these terms and they can be used interchangeably.

Please note, all wireless devices – such as cell phones, cordless phones and WiFi routers - have transmitting antennas. There have been many warnings on exposures to these devices as well. In particular cell and cordless phones, due to being held to the head, give much higher short-term exposure to RFR. **If anyone would like more information on cell and cordless phones please refer to Dr. Devra Davis's website Environmental Health Trust at** http://www.environmentalhealthtrust.org/content/cell-phones

I am a public health advocate. I am not an expert in this field, however I have researched this issue for the last four years. I started this research after I moved into a house that was 300 feet from cellular antennas and found myself unable to sleep for more than four hours a night and had difficulties with my mental capacity. I found I could not spell simple words and that my short-term memory was failing. After moving away from the antennas I no longer have these symptoms. From my international networking I have found countless numbers of people who have gone through similar experiences. From my research and my networking on this issue I am convinced that millions of people are being harmed by exposure to EMF/RFR at levels that are deemed safe by our government. As our government has not acknowledged this it is now my work to educate people so that they can take measures to minimize their exposure.

The Federal Communications Commission's (FCC) RFR exposure standards for wireless transmitters have been formulated with the intent to protect us from thermal heating based on 30 minutes of exposure. You may have heard that there is no evidence of harm other than thermal heating from exposure to RFR. The CDC, FDA and the FCC all make this claim. This simply is not true. If one closely examines the body of research on EMF/RFR exposures it becomes apparent that the majority of the industry funded studies show no effect while the majority of the independent studies do.** Studies funded by the mobile phone industry are more than six times more likely to find "no problem" than studies funded by independent sources. Both sides offer conjecture as to why this is so. But the claim by industry and governmental agencies that there is no evidence is plainly false. If the industry funded studies are excluded, the weight of the evidence is that there are indeed non-thermal biological effects, many of which are harmful to health, that occur at exposure levels far below the FCC exposure standards.

*Internet routers, smart meters and smart boards may operate with either wired or wireless networks.
**(The cell phone industry has funded at least 87% of the research on this subject. See - http://andrewamarino.com/PDFs/CellphoneEMFs-Review.pdf)

A QUICK BACKGROUND

A quick background, we all know that RFR from a microwave oven heats food. The thermal effect is well established. The controversy over this issue is due to the belief of many scientists and governments that RFR can only have a heating effect and our exposure standards protect us from this heating, therefore they claim that it is perfectly safe to have RFR emitting devices in our bedrooms and next to our schools.

Why do they say this? Speculation is that it has to do with the money. Just as the tobacco industry was able to suppress science, the telecommunications industry suppresses science. They fund studies that find no results. They marginalize the researchers in the field who do find harmful effects. (Please see Study Bias Report in references.)

This massive industry had combined revenues of more than $4.9 trillion in 2009. In 2007 the U.S. telecommunications industry spent almost $250 million on political lobbying. Over the past decade, they have spent a grand total of nearly $2.4 billion. Over 247,081 antenna sites have already been approved nationwide without any federal studies to assure the safety of those living nearby.

(See
http://www.plunkettresearch.com/Telecommunications/TelecommunicationsStatistics/tabid/96/Default.aspx and

http://articles.mercola.com/sites/articles/archive/2008/11/29/interview-with-expert-on-dangers-of-cell-phones.aspx)

THE BIONITIATIVE REPORT

The **BioInitiative Report**, published in 2007, provides detailed scientific information on health impacts when people are exposed to EMF/RFR hundreds or even thousands of times below limits currently established by the FCC. The authors reviewed more than 2000 scientific studies and reviews, and concluded that the existing public safety limits are inadequate to protect public health. Their conclusion is that: From a public health policy standpoint, new public safety limits, and limits on further deployment of risky technologies are warranted based on the total weight of evidence. Their recommendation is to set an exposure standard of **0.1 microwatt per centimeter squared (μW/cm²) limit.** This is 10,000 times lower than the FCC standard of 1,000 1 μW/cm².

The report includes studies showing evidence for:

• Effects on gene and protein expression
• Genotoxic effects
• Stress response
• Effects on immune function
• Effects on neurology and behavior
• Brain tumors and acoustic neuromas
• Childhood cancers (leukemia)
• Reduced Melatonin production
* Alzheimer's disease
* Breast cancer

HOT SPOTS

Cellular antennas have power peaks at predetermined distances. These vary and are influenced by compounding exposure factors that can cause localized increases of RFR levels. Some of these factors are: other RFR emissions, from WiMax, WiFi, cordless phones, etc. in the area will add to the overall RFR burden; reflective materials reflect RFR and create hot spots (just as they do in microwave ovens); and, metal and wires are RFR conductors and may amplify the signals. In addition locations closest to and/or in direct line of sight of the transmitters will have elevated RFR levels relative to surrounding locations. The Occupational Safety and Health Agency (OSHA) reports: *Metal objects such as steel beams can act as antennas by receiving and then "re-radiating" some of the energy, forming a new radiating surface to consider.* ***Not only does this new radiating surface have its own near-field regions, the energy levels might be shockingly high. Exercise caution near such metal objects."*** *(http://www.osha.gov/SLTC/radiofrequencyradiation/electromagnetic_fieldmemo/electromagnetic.html)* These factors may perhaps cause the people who are in the elevated RFR zones over the tipping point into electrohypersensitivty (EHS) (Explained later).

Our bodies may also have localized internal hot spots. Due to the variable shape, size and thickness of our skulls and dependent on our particular resonance to the frequency of the RFR **regions of relatively high absorption can occur at or near the center of the brain causing internal hot spots**, which can result in tissue damage long before the overall body temperature shows a measurable increase.

Due to a lack of adequate vascular systems for the exchange of heat our eyes are also most susceptible to harm from RFR exposure, which can result in protein coagulation and opacities in the lens. The male testes are another organ particularly susceptible because there is no direct blood supply and therefore no way of dissipating heat.

According to the BioInitiative Report, the RFR level we evolved with was a billionth of a microwatt per centimeter squared (10^{-12} $\mu W/cm^2$) In 1997 the background RFR levels measured by Ed Mantiply of the FCC at areas on the ground near towers had increased 0.003 to 0.3 $\mu W/cm^2$. A survey by Sage Associates in 2000 found RFR levels within 300 feet from cell towers to range from 0.01 to 3.0 $\mu W/cm^2$. And an RFR survey near cell towers in Germany in 2002 found RFR levels of 0.02 to 10 $\mu W/cm^2$. These readings were the highest at homes that were closest to and in direct line of sight of the transmitting antennas. **More recently, transmitters installed by T-Mobile on utility poles in San Francisco may emit RFR levels up to 190 $\mu W/cm^2$.***

* (http://noevalleyvoice.com/2009/December-January/T-Mo.htm)

RFR monitoring uses spatial averaging -

"Spatial-averaging is an RF radiation measurement technique used to determine the amount of RF exposure at a particular spot by averaging the electric and magnetic fields (squared) over an area equivalent to the area normally occupied by a standing human body. The FCC ... expressed concerns about situations where a localized (spatial peak) field intensity exceeds the exposure limits near an antenna (which is potentially accessible to workers or the public) despite the fact that the spatially averaged measurement over the area indicates compliance with exposure limits. ***The concern is that localized hot spots could lead to exposure in the body of a nearby person that exceeds the partial-body limits while not exceeding the whole-body limit."***
(http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65)

At my former home, which was 300 feet from cell phone antennas located on a two-story building with direct line of sight, the RFR measurements were at the highest level at my head height and the lowest level was at my feet. Personally I am more concerned about the RFR going straight to my head than I am over the average of the exposure to my entire body and I find the use of spatial averaging to be a duplicitous method of determining safe exposure levels to RFR.

GUIDELINES

According to researcher Magda Havas, PhD, BSc, RFR exposure guidelines, used in our wireless communications, range 5 orders of magnitude in countries around the world. Salzburg, Austria recommends that RFR levels be kept to: Outside 0.001 $\mu W/cm^2$ and Inside 0.0001 $\mu W/cm^2$. **The U.S. exposure guideline is 1000 $\mu W/cm^2$.** In China, Russia, Italy, Switzerland and Monaco the guideline is 10 $\mu W/cm^2$..

Why do we have guidelines that are so much higher? Our guidelines are based on a short-term (30-minute) heating effect called the Specific Absorption Rate (SAR). It is assumed that if this radiation does not heat your tissue it is safe. This is not correct. Effects are documented at levels well below those that are able to heat body tissue. These biological effects include increased permeability of the blood brain barrier, increased calcium flux, increase in cancer and DNA breaks, induced stress proteins, and nerve damage. Exposure to this energy is associated with altered white blood cells in children; childhood leukemia; impaired motor function, reaction time and memory, headaches, dizziness, fatigue, weakness and insomnia.

While most people want wireless communications, the siting of transmitters needs to be based on minimizing harm. If there will be children or homes close to the antennas these **people are more susceptible to harm from RFR exposure as chronic long-term exposure leads to cumulative damage and the development of electrohypersensitivty and children's smaller bodies absorb more radiation.*** In addition, wildlife, with bees in particular, may have their navigational abilities interfered with due to RFR exposure.

**Lai and Singh confirmed in 1997 that EMF exposure has cumulative effects.*

The report, **Merger of Two Different Dosimetry Rationales - August 2009**, out of Russia, compares the two approaches to establishing exposure guidelines. It says:

http://www.piers.org/piersproceedings/piers2k9MoscowProc.php?start=0

Merger of Two Different Dosimetry Rationales
Sergey Yu. Perov, Quirino Balzano, and Niels Kuster
PIERS Proceedings, 157 - 160, August 18-21, Moscow, RUSSIA 2009
(Access the html version here - http://tiny.cc/2CIgv)

"...One approach is based on the measure or estimate of specific absorption rate [SAR used in the U.S.], which is the power absorbed per unit weight of an object. The other relies on the measure of the time integrated radiofrequency power density incident on an object. [Cumulative biological effects used in Russia.]...

*...**the Russian Federation exposure limits are founded on chronic biological effects caused by non thermal EMF exposures**; the effects were investigated using behavioral, electrophysiological, hematological and biochemical methods...*

The biological effects of EMF exposure (depending of reaction intensity) can be divided into several categories: perception, adaptation, compensation, reparative regeneration, pathology. Each step of reaction can be characterized by its own threshold EM values of intensity and development times. ***The magnitude of an effect grows not only with the exposure intensity but also with the exposure time.*** *Progressing through stages of reactions to EMF exposure of various intensities, it is possible to define a range of outcomes..."*

Russia's RFR exposure standard is 10 μW/cm² compared to the 1,000 μW/cm² standard used in the U.S.

Below are excerpts from Wolfgang Scherer's report on the cumulative exposure to RFR and the need for new exposure standards:

http://www.reach.net/~scherer/p/biofx.htm

"...To be useful exposure standards have to give a peak limit and a dosage limit. The power we get from our utility is measured in Kilo-Watt-Hour, a unit used to measure accumulated power consumption over a time period. A unit for accumulated exposure to radiofrequency radiation should be established in the same manner, for example mWh/cm². If we use the exposure rates allowed by [Canadian] Safety Code 6 we get as an accumulated dose 1 mWh/cm² for one hour but 0.4 mWh/cm² for a minute... ***science has yet to come up with a dose that can be endured without damage, setting a radiation level that can be considered safe for permanent exposure****...*

From the allowable occupational exposure it could be calculated that by multiplying this number with 8 hours of a work shift, an allowable dose of 8 mWh/cm² per day could be established. But this would then only be valid for an 8-hour work shift with a 16-hour recovery period and would establish an occupational exposure level only.

A further linear reduction to 0.3 mW/cm² as a permanent exposure rate causing the same dose over a 24-hour period is merely a mathematical exercise and does not address accumulation with no recovery period. More problematic if that exposure is not occupational but involuntary."

Our genetic, chemical, piezoelectric and resonant variation all factor into how much energy is absorbed upon EMF/RF exposure. The rate that we can release energy (heat) also varies between individuals. These varying factors mean that we do not absorb EMF/RF equally and we do not release the energy equally. Our exposure guidelines need to take in these factors as well as the cumulative effect from EMF/RFR exposure.

THE STUDIES

Industry and governments state that there are no studies proving cell towers are unsafe. While it is true that it is impossible to exactly duplicate our ambient exposures to RFR in the environment in a laboratory setting, **there are numerous studies, which show**

biological harm at RFR levels well below our environmental exposure from neighborhood cell towers.

There are more than 13,000 studies on Pub Med on the topic of EMF/RFR exposure and possible harmful effects. I do not have the expertise or the time, and I imagine you do not either, to go through all of these studies to determine if the studies are sound or if they are flawed. Most studies have some flaws, as there are limitations to replicating and measuring real time exposure to RFR. I am relying on the work of researchers in this field and reporting on their findings.

As there are very few valid epidemiological studies on cell towers and health – The World Health Organization has only 14 studies that meet their criteria in their database – it is necessary to examine evidence of exposures that are of a similar level as one would receive from RFR antennas on a cell tower. I have included some of these studies. (See Studies on Low Level Non Thermal Biological Effects of EMF/RF in the reference section.)

Included in Dr. Magda Havas' WiFi report for San Francisco, Dr. Henry Lai, PhD, compiled a list of studies that document biological effects of RFR at low intensities. (See http://www.magdahavas.com/2009/10/17/wifi-proposal-for-san-francisco/)

"All of the 40 reports, reviewed by Dr. Henry Lai, document biological effects or associations, many of them adverse or undesirable, at exposure to RFR below the FCC guidelines for both power density (1000 $\mu W/cm^2$) and specific absorption rate (0.08 W/kg). Of the 12 studies that provide power density data, 11 document effects below 41 $\mu W/cm^2$ (scenario of woman using her laptop computer on her balcony); 6 document effects below 6 $\mu W/cm^2$ (exposure to multiple Wi-Fi antennas); and 3 document effects below 1$\mu W/cm^2$ (exposure to 1 Wi-Fi antenna)."

Epidemiological evidence also shows cause for concern over RFR exposure from cell towers.

In fact 10 out of the 14 peer-reviewed studies analyzed, and conforming to the specified WHO/ICNIRP standards of scientific quality, including their assessment criteria of consistency and replication found significant increases in ill health effects. Included in this database are only those studies that are about cell tower exposures. (Kundi, 2008 at the London EMF International Conference). Populations close to cellular antennas show an increase in the effects of ill health in those closest to the antennas with the risks factors dropping off as distance and RFR levels decrease. Symptoms ranged from sleep disturbances to breast and brain cancers.

Researchers at Powerwatch UK found that 26 out of 44 epidemiological studies that met their criteria show significant health risks.

Epidemiological studies are not proof of cause, however they do show associations and are used to set policy on many environmental exposures. In fact there is very little scientific proof that tobacco causes lung cancer or even for ionizing radiation and ill health effects. For the most part we rely on epidemiological studies to show the strong correlation between environmental exposures and ill health.

BIOLOGICAL PROCESSES

What is going on here? All electronic devices have an EMF field. Our wireless communications devices also emit RFR. Basically when an electric field is turned on and off fast enough, it switches to a magnetic field and back to an electric field repeatedly, this creates electro-magnetic radiation.

Subsequently, RFR causes the polarity in cells to continuously reverse. This is what causes heating in our food in our microwave ovens. But what happens to living biological systems when the polarity of cells continuously reverses? This phenomenon interferes with cellular function and may explain why there is a wide range of symptoms from RFR exposure. According to Andrew Goldsworthy, BSc, PhD, additionally, *"our wireless communication devices use amplitude-modulated radio waves where the signal strength rises and falls. These have been shown to be further damaging as they can remove structurally important calcium ions from cell membranes at levels far below the thermal effect. This results in an increased leakage of materials through cell membranes that can affect many aspects of metabolism. These include damage to DNA, from digestive enzymes leaking from lysosomes, apoptosis (cell death), the generation of false nerve impulses from calcium leakage in brain cells (causing hyperactivity, impairing normal mental function and generating many of the known symptoms of electromagnetic hypersensitivity.)*

Claims by the industry that the cellular antennas are safe because the radiation falls off rapidly with distance are flawed. The biological response will remain more or less constant over a wide range of signal strengths due to the ways in which living cells routinely use 'negative feedback' to compensate for changes in their environment."

VULNERABLE POPULATIONS

ELECTROHYPERSENSITIVTY

A growing population is adversely affected by these electromagnetic frequencies. Long-term chronic exposure to RFR may lead to electrohypersensitivty (EHS). EHS is recognized as a disability in Sweden where it is estimated that up to 3% of the population is EHS. Magda Havas, PhD, a researcher in this field, has stated that from her research she finds that up to 35% of the population exhibits some sensitivity.

EHS is the term for people who are highly sensitive to electric and magnetic fields and to radio frequency radiation (EMF/RF). While some people appear to be EHS upon initial exposure to high EMF/RF fields, many other people appear to succumb to a cumulative effect. That is after a certain amount of time, all future exposure to EMF/RF results in a pathological response. This is consistent with findings from Russia and their exposure standards reflect this.

The World Health Organization defines EHS as:

http://www.who.int/mediacentre/factsheets/fs296/en/index.html

"[...A phenomenon where] individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs)...EHS is a real and sometimes a debilitating problem for the affected persons, while the level of EMF in their neighborhood is no greater than is encountered in normal living environments. Their exposures are generally several orders of magnitude under the limits in internationally accepted standards."
The WHO Fact sheet goes on to state:

"Treatment of affected individuals should focus on the health symptoms and the clinical picture, and not on the person's perceived need for reducing or eliminating EMF in the workplace or home. "

This indication that EHS is a mental disorder rather than biologically caused from exposure to EMF/RFR is replicated throughout governmental agencies and has led to a worldwide citizen movement of EHS sufferers having to resort to their own efforts to remove themselves from high EMF/RFR exposures.

However this situation is changingg, at a meeting in May 2011, the WHO Department of Public Health and Environment on the International Classification of Disease, which is the international standard to measure health and health services recognized Electrohypersensitivity (EHS).

(Since 1948, WHO is responsible for the international classification of diseases and every 10 years a review of this classification takes place. Currently the WHO is working on the next review that should be completed by the year 2015.)

Following are notes from the meeting:

[NOTES - Excerpts]

basic questions to address the issue of Multiple Chemical Sensitivity (MCS) and Electrohipersensibility (EHS).
a) MyS and EHS are real health problems.
b) There is evidence to confirm this statement:
- *Medical diagnostics.*
- *Reports of work inspections establishing causality between exposure and disease.*
- *There are scientific studies that confirm its existence.*
- *There is a recognition by the European Parliament of these diseases, evidence that is provided in the dossier presented today.*
- *There are 200 judgments in favor in Spain that support this evidence.*
- *We are getting in Spain (economic) 'compensation' for patients.*

The adverse reactions to chemicals or electromagnetic radiation vary in duration according to each patient, and the manifestations differ too. When the patient is again exposed, symptoms usually worsen or result in the appearance of new symptoms.
The process of these diseases (MCS and EHS) is chronic and the patient's situation is exacerbated if he/she lives in a toxic environment, such as near Tarragona petrochemical industry or subjected to electromagnetic radiation: emissions in the neighborhood, mobile phone antennas , etc. The patient has to avoid re-exposure.

Perhaps the most delicate aspect is the fact that MCS and EHS are multisystemic diseases and could be placed in different fields of classification (medical specialities), although we must not forget the great importance of the neurological symptoms. We need to establish a new medical paradigm that answers some questions referring to these emerging diseases, including their classification in the ICD.
4 .- The WHO knows that these conditions exist.
5 .- Within WHO the emergence of these diseases has generated a controversy, but the explanation of changes in the methodology of work for the development of the ICD for calendar 2015 and possible participation in working groups opens new possibilities for recognition.
6 .- Each country can recognize these diseases and include them in their ICE, independently of WHO, since according to the WHO countries have sovereignty on this issue.
Source: *http://www.asquifyde.es/noticia-detalle.aspx?noticia=1330*

Dr. Havas' double blind 100 person study on self-identifying EHS subjects and controls examined the heart's reactivity to the RFR emitted by common DECT cordless phones. Most of the volunteers did not respond to the exposure, but those who did respond experienced arrhythmia (irregular beats of the heart) and/or tachycardia (rapid heart rate). These symptoms were often accompanied by feelings of anxiety.

While other exposure studies on self-identifying EHS subjects have not found such strong evidence, these studies have not measured biological effects. Rather they relied on subjective reports from the test subjects.

Symptoms of EHS include sleep disturbance, fatigue, pain, nausea, skin disorders, problems with eyes and ears (tinnitus), and dizziness. Again, it is estimated that 3% of the population are severely affected and another 35% have moderate symptoms. Prolonged exposure may be related to sensitivity and for this reason it is imperative that children's exposure to RFR be minimized as much as possible.

CHILDREN'S SENSITIVITY

Children are more sensitive to environmental contaminants and that includes RFR. Their smaller bodies proportionally absorb more RFR than adult bodies. The Stewart Report (UK 2000) recommended that children limit their use of cell phones only for emergencies. Many countries including France, the United Kingdom, Russia, Japan, Germany, Israel, India, Austria and Belgium have all issued public health warnings regarding children and have placed limitations on cell phone use, WIFI in schools and even changed EMR regulations. (See http://thepeoplesinitiative.org///Home_Page.html)

CONCLUSIONS AND WARNINGS

WARNINGS

Scientists, doctors and governmental agencies worldwide have issued warnings, restrictions and resolutions urging limiting exposure to EMF/RF. Due to the numbers of people suffering from symptoms of EHS, medical doctors and scientists have issued resolutions stating that there is a more sensitive population to RFR and that antennas should not be sited near homes, schools and hospitals. These run from the Vienna Resolution in 1998 through to the Porto Alegre Resolution in 2009.

In 2009 and 2010 **three U.S. Governors**, of Florida, Connecticut and Colorado, declared Electrohypersensitivty Awareness months.

In May, 2009 the **LA Unified School District**, which restricts cell towers on school property passed a resolution attempting to restrict antennas near school property and in April, 2009, the **EU Parliament** adopted, by 559 votes to 22, with 8 abstentions, a resolution on health concerns associated with electromagnetic fields (EMFs) which includes criteria for setting up [Cell Towers] and high-voltage power lines. They state: *"In this context, it is important to ensure at least that schools, crèches [nursery schools], retirement homes, and health care institutions are kept clear, within a specific distance determined by scientific criteria, of facilities of this type."*

The Vancouver School Board (VSB) passed a resolution in January 2005 that prohibits construction of cellular antennas within 1000 feet (305 m) from school property.

Palm Beach County, Florida, the city and county of Los Angeles, California, and New Zealand have all prohibited cell phone base stations and antennas near schools due to safety concerns. The decision not to place cell antennas near schools is based on the likelihood that children are more susceptible to this form of radiation.

In January 2008, the National Research Council (NRC), an arm of the National Academy of Sciences and the National Academy of Engineering, issued a report saying that we simply do not know enough about the potential health risks of long-term exposure to RF energy from cell phones themselves, cell towers, television towers, and other components of our communications system. **The scientists who prepared the report emphasized, in particular, the unknown risks to the health of children, pregnant women, and fetuses as well as of workers whose jobs entail high exposure to RF (radiofrequency) energy.** The report called for long-term safety studies on all wireless devices including cell phones, computers, and cell phone towers and states:

"Wireless networks are being built very rapidly, and many more base station antennas are being installed. ***A crucial research need is to characterize radiated electromagnetic fields for typical multiple-element base station antennas and for the highest radiated power conditions with measurements conducted during peak hours of the day at locations close to the antennas as well as at ground level."***

CONCLUSIONS

The FCCs Telecommunications Act of 1996 (TCA) [47 U.S.C. 332 (c)(7)(B)(iv) of Section 704 preempts local governments from effectively regulating the placement of wireless communications facilities on the basis of potential or known environmental effects from f radiofrequency radiation. It has been assumed that this prohibits local governments from considering siting on an environmental and health basis. However in this case the regulation does not specifically state health effects, therefore, health effects are not subject to the preemption.

The wireless industry continues to perpetuate the fiction that federal law preempts basing the siting of transmitters due to known or potential health effects from RFR, and, local governments, fearful of being sued by one of the most powerful industries, have not been willing to challenge this misinterpretation of the TCA.

The FCC issued a recent ruling (11/18/09) on antenna siting. They found: *"In the event a State or local government fails to act within the appropriate time period, the applicant is entitled to bring an action in court under Section 332(c)(7)(B) (v) of the Communications Act, and the court will determine whether the delay was in fact unreasonable under all the circumstances of the case. We conclude that the record supports setting the following timeframes: (1) 90 days for the review of collocation applications; and (2) 150 days for the review of siting applications other than collocations.*

*Accordingly, if State or local governments do not act upon applications within those timeframes, then a "failure to act" has occurred and personal wireless service providers may seek redress in a court of competent jurisdiction within 30 days, as provided in Section 332(c)(7)(B) (v). The State or local government, however, will have the opportunity to rebut the presumption of reasonableness."**

(* http://www.fcc.gov/ November 18, 2009 "FCC Issues Declaratory Ruling Establishing Timeframes for State and Locality Processing of Applications for Wireless Towers")

This means that once an antenna application has been filed the wireless company can sue the state or local government if they have not either approved or denied the application within 150 days. This new ruling will force much faster action on cell tower siting than there has been in the past. Montgomery County, MD filed comments to the FCC against this new ruling, as did many local governments. Our current President Obama also filed comments against this while he was still a Senator from Illinois. The CTIA petition to the FCC asked that an antenna application be considered passed if it was not denied within 45 days so the FCC did not give in completely to their shot clock request.

The wide variance in RFR exposure limits around the world is due to the fact that some countries dismiss non-thermal biological effects from RFR exposure. Their limits only protect against thermal heating. Many countries - New Zealand, Italy, China, Bulgaria, Hungary, Russia, Switzerland, Austria and New South Wales, Australia - have lower limits that factor in the non-thermal cumulative effects, which have been shown to occur at levels thousands of times lower than the thermal effects. The BioInitiative Report recommends an RFR exposure level of 0.1 $\mu W/cm^2$. Our standard is 1,000 $\mu W/cm^2$. According to Norbert Hankin, an environmental scientist in the U.S. Environmental Protection Agency's Office of Radiation and Indoor Air, who has studied the effects of RFR for 33 years, it is not clear how protective current safety standards are because they are based on preventing the radiation from heating tissue and do not take into account research that has shown biological changes, such as DNA breaks, at much lower levels of exposure.

I do not know what the current background ambient RFR levels are, but as we are experiencing a continuous growth in wireless antennas it is presumably higher than the level found in 2000. Each additional antenna adds to this background level. This means that WiFi, Smart Boards, Smart Meters, DECT cordless phones and individual cell phones and PDAs all add to the ambient background RF levels found near cell towers.* It is the people who will have long-term involuntary exposure within approximately 1,000 feet (excepting compounding amplifying RF factors) of the antennas that are most susceptible to harm.

* This survey found that the highest RF exposure environments were on public transportation and likely due the microwave oven effect from the multiple personal wireless devices in use. Mohler E., Frei P., Braun-Fahrländer C., Bürgi A., Egger M., Fröhlich J., Joos N., Neubauer G., Theis G., Röösli M. Personal radio frequency electromagnetic field exposure at different locations. Umweltmedizin in Forschung und Praxis 2008, 13 (5): 287-288. Read Abstract http://www.ispm.ch/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Qualifex/Abstracts/Abstract_E_Mohler_Graz.pdf&t=1284604616&hash=d12a9bef92594b371c319e674f0b3494

On May 31, 2011 the world's leading experts of the **International Agency for Research on Cancer (IARC)**, part of the World Health Organization, issued a joint statement that cell phone and other types of radiofrequency (RF) and microwave radiation are now class 2B carcinogens. This places RF under the same category as exposure to gasoline and coffee. We do not serve coffee to children, and certainly would not place a gas station on school property and cell towers do not belong there or near our homes. Children should have limited access to cell phones and other wireless devices. RF emitting devices now deserve the same precautions as other Class 2B carcinogens. This new classification demands immediate action by our public officials and the health community.

There are simple measures that will minimize harm from EMF/RFR exposure, such as: keeping WiFi routers out of areas where more time is spent, or even better turned off when not in use; making sure wiring is grounded and either shielded, braided or twisted, which mitigate their picking up and amplifying EMF/RFR; minimizing metals in and out of our bodies; keeping antennas from having direct line of site and at a minimum of 1,000 feet of homes and schools, etc (Although this is dependent on the strength of the transmitters.); minimizing electric devices in bedrooms; making DECT cordless phones and WiFi routers that only emit RFR when in use; and only using cordless and cell phones with head sets, speaker mode and texting. Use wired systems wherever possible. Broadband internet and smart boards and meters are all faster and more secure over wired networks.

More complex measures would be to have system compatibility and planned infrastructure roll out. With our Business As Usual attitude this may no longer be possible. Instead of creating the false siting restrictions based on appearance, we should have based it on health. Antennas should be sited where they will do the least harm and anyone who is in a EMF/RFR hot spot should be compensated in some way. Shielding or relocating would both help. The best way to avoid intended and unintended RFR is to install fiber optics as the system has no RFR emissions. Instead of adopting these measures, the injured are left to their own devices. Industry has done its best to label the people they have harmed as being crazy.

In addition to the above measures, Dr. George Carlo, chairman of the Wireless Technology Research program (WTR) from 1993 – 1999, a $28.5 million research program, funded by the cellular phone industry that investigated the possible health effects of cellular phones wrote in a recent article in the American Trial Lawyer that:

"Laws should be enacted to place health warnings on cell phones and wireless devices, as well as warning signs in public spaces that carry WiFi and other wireless signals.

The Telecommunications Act must be amended to include victims' compensation provisions; incentives for the development and commercialization of technologies to [protect] users from harmful electromagnetic radiation; and civil rights provisions to promote environmental and health risk protection for homeowners in communities where cell phone base stations and other wireless infrastructure are constructed."

It is imperative that the U.S. government reexamines our RFR exposure level and adjusts it to protect populations from having their health adversely impacted by RFR exposure. The Telecommunication's Act of 1996 needs to be revised to allow local oversight and health concerns as part of the criteria for antenna siting. **The Coalition for Local Oversight of Utility Technologies is working on this effort here in the U.S.** I urge you to get involved and advocate for lower RFR exposure standards. **Please go to http://www.cloutnow.org to find out how you can get involved in this important work.**

REFERENCE WEBSITES

Cell Tower Siting

International Conference on Cell Tower Siting
Linking Science & Public Health
Salzburg, June 7-8, 2000

www.salzburg.gv.at/celltower_e
http://www.salzburg.gv.at/themen/gs/gesundheit/umweltmedizin/elektrosmog/celltower_e.htm

Summary
...The rapid development in the mobile telecommunications area led and leads to an increasing burden of exposure due to electromagnetic fields in the immediate environment of the population. In order to guarantee, that these technologies, working in the high-frequency range with variable modulations, have no negative impacts on human health and well-being, it is essential to restrict the exposure...

In 1998 ICNIRP (International Commission on Non-Ionizing Radiation Protection) a NGG acknowledged by the World Health Organization (WHO), proposed reference values for the protection of human health from non-ionizing radiation. ICNIRP holds the position, that in the high frequency range relevant effects on human health only appear in the case of excessive warming of tissues of more than 1° Celsius which is related to a specific absorption rate (SAR) of 4 watts/kg tissue. In order to protect also sensitive persons from excessive heating an uncertainty factor of 50 was introduced resulting in an SAR of 0,08 W/kg. Because the SAR is only measurable on a phantom or by a computer model a so called reference level is derived for example as field strength [V/m or A/m] or as power flux density [W/m2]. The reference levels proposed by ICNIRP for the currently used mobile telecommunications frequencies, 900 MHz and 1800 MHz, are 4500 mW/m2 (450 £gW/cm2) and 9000 mW/m2 (900 £gW/cm2) respectively.

The International Conference on Cell Tower Siting made it clear, that the proposal of ICNIRP for the protection of human health from highfrequency electromagnetic fields, on which the current recommendations of WHO and EU-Council are based, are on the one hand scientifically untenable and on the other hand not able to protect human health...

Cell Tower Siting – A Public Health Issue*
Dr. Gerd Oberfeld, Dr. Christoph König

...As the Salzburg Model demonstrates, through the cooperation of citizens, politicians, governmental authorities and network operators, base stations can be situated, erected and configured so that the acceptance of the local residents, the protection of health in accordance with the recent information, and the protection of the community image and the landscape are all taken into account. The degree of exposure to electromagnetic fields from exterior base stations can vary greatly and differ by several orders of magnitude. Factors influencing the degree of exposure include:

..Effective isotropic radiation power (EIRP) per station. This depends, for instance, on:.

- The transmitting power of the organisation channel
- The number of conversation channels and their utilisation rate as well as the regulation of the radiation power
- Antenna gain
- Vertical loss and for sector antennas also the horizontal loss of the respective antennas
- The distance from the respective base station as well as a possible weakening of the signal through buildings, trees, etc.
- In interior rooms, depending on the existance, the type and execution of walls, windows and the roof, the degree of exposure may be the same as outdoors, or may be lowered by several orders of magnitude.

Hot Spots and Reflective Environments

OET Bulletin 65 FCC Guidelines for Evaluating Exposure to RF Emissions .... 7 ...

http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65

FCC on Spatial Averaging and Hot Spots When using a broadband survey instrument, spatially-averaged exposure levels may be determined by slowly moving the probe while scanning over an area approximately equivalent to the vertical cross-section (projected area) of the human body. ...The term "hot spots" has been used to describe locations where peak readings occur...Often such readings are found near conductive objects, and the question arises as to whether it is valid to consider such measurements for compliance purposes. According to the ANSI C95.3 guidelines (Reference [2]) measurements of field strength to determine compliance are to be made, "at distances 20 cm or greater from any object." Therefore, as long as the 20 cm criterion is satisfied, such peak readings should be considered as indicative of the field ***at that point...***in many situations there may be several RF sources. For example, a broadcast antenna farm or multiple-use tower could have several types of RF sources including AM, FM, and TV, as well as CMRS and microwave antennas...In such situations it is generally useful to use both broadband and narrowband instrumentation to fully characterize the electromagnetic environment. Broadband instrumentation could be used to determine what the overall field levels appeared to be, while narrowband instrumentation would be required to determine the relative contributions of each signal to the total field if the broadband measurements exceed the most restrictive portion of the applicable MPEs...

Influence of the reflective environment on the absorption
by G Vermeeren - 2010
Sep 1, 2010 ... (Hagmann and Gandhi 1979, Durney et al 1986, Vermeeren et al 2007, ...From the literature review, it is clear that worst-case exposure scenarios ... The inhomogeneous virtual family male (VFM) (Christ et al 2010) shown ...

http://iopscience.iop.org/0031-9155/55/18/018;jsessionid=9AB8D4ECBADF3A104820FA7B7BD2EE87.c2

The Swiss ITIS laboratory for testing of RF wireless emissions study looked at reflections, which can occur in daily living and working environments within close proximity to cell antenna base stations (30 cm, 1 meters, 3 meters and 10 meters), which could lead to greater exposures than predicted by assessments of RF sources in 'free space'.

They reported that by looking at more realistic "reflective environments", the ICNIRP safety limits may be violated due to varying exposure environments.

Passive Exposure to Mobile Phones: Enhancement of Intensity by Reflection
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(Received March 14, 2006; Revised May 18, 2006; Accepted May 23, 2006; Published July 25, 2006)

http://jpsj.ipap.jp/link?JPSJ/75/084801/

In a recent Letter [J. Phys. Soc. Jpn. 71 (2002) 432], we reported a preliminary calculation and concluded that public exposure to mobile phones can be enhanced by microwave reflection in public spaces. In this paper, we confirm the significance of microwave reflection reported in our previous Letter by experimental and numerical studies. Furthermore, we show that "hot spots" often emerge in reflective areas, where the local exposure level is much higher than average. Such places include elevators, and we discuss other possible environments including trains, buses, cars, and airplanes. Our results indicate the risk of "passive exposure" to microwaves. ©2006 The Physical Society of Japan

"We furthermore confirm the existence of microwave "hot spots", in which the microwaves are "localized". The intensity measured at one hot spot 4.6 m from the transmitter is the same as that at 0.1 m from the transmitter in the case without reflection (free boundary condition). Namely, the intensity at the hot spot is increased by approximately 2000 times by reflection."

[PDF] HF-RADIATION LEVELS OF GSM CELLULAR PHONE TOWERS IN RESIDENTIAL AREAS
File Format: PDF/Adobe Acrobat - Quick View
exposure assessment for cellular phone tower radiation in Germany. .... antenna site, the GSM radiation levels are scattered due to various .... possible role of radio-frequency radiation in the development of uveal melanoma" in: ...

http://pdfcast.org/pdf/hf-radiation-levels-of-gsm-cellular-phone-towers-in-residential-areas

RFR levels at cell towers in Germany in 2002 ranged from:
Low reading: .02 μW/cm² (200 μW/m²)
High reading: 10 μW/cm² (100,000 μW/m²)
1uw/m² = .0001 μw/cm²

Abstract (Excerpts)
...A statistical evaluation of over 200 representative high frequency field measurements is presented for the years 2001 and 2002. Measurements were conducted at different distances and directions using a frequency selective spectrum analysis to obtain only GSM power densities... Derived from this data, GSm cellular phone tower radiation is dominant in comparison to FM radio or TV emissions. The median power density was found to be in the range of 200 μW/m² with the maximum level exceeding 100,000 vW/m². A total of 25 percent of the power densities exceeds 1,000 uW/m², which has been suggested to be the average threshold value for non-thermal biological effects. Two of the most important factors are the distance and the direct line of sight to the antenna site. At the typical residential cell tower distance of about 250 m in cities, with direct line of sight, the observed levels are in the range of 200 μW/m². The results show that, especially for future cellular UMTS applications, there are several options to minimize additional HF radiation exposures for the population and reduce the potential risk for harmful exposures...

...Distance, Line of Sight and Exposure Parameters
The power density values are displayed in Figure 2 in respect to line of sight/without line of sight and the distance to the antenna site. It is obvious, that especially in proximity to the

antennas site (<250 m), the GSM radiation levels are scattering due to various influencing parameters and cannot be calculated easily by using antenna power and distance modest only. Table 1 shows a significant systematic difference between the percentile data from line of sight and without line of sight measurements. Figure 2 displays the separated sets of data with trend lines decreasing exponentially to larger distances with lower exposures for without line of sight measurements in the range of 90% reduction (-10dB).

In general, the radiation exposure is predominantly determined by e.g. the following parameters:

Distance to antenna
Line of sight to the antenna site
Type of antennas, e.g. omni directional or directional antennas
Number, power, and orientation of the antennas
Capacity of the antenna site (number of channels/frequencie s)
Vertical distance between location and antenna site
Type of building construction/ type of window glass
Total reflection of the environment
...Directly below roof top positions (e.g. schools, preschools, homes) significant exposures in the range of a few 1,000 $\mu W/m^2$ were observed due to secondary side lobes and reflections. During our data collection, the highest exposure values in the range of 10,000 - 100,000 $\mu W/m^2$ were observed very close to low antenna/roof top positions at inside and outside locations in line of site and distance < 100 meter.

RFR Exposure Assessment/Dosimetry

Merger of Two Different Dosimetry Rationales - August 2009

http://www.piers.org/piersproceedings/piers2k9MoscowProc.php?start=0

Merger of Two Different Dosimetry Rationales
Sergey Yu. Perov, Quirino Balzano, and Niels Kuster
PIERS Proceedings, 157 - 160, August 18-21, Moscow, RUSSIA 2009
(Access the html version here - http://tiny.cc/2CIgv)

...RUSSIAN EXPOSURE ASSESSMENT AND DOSIMETRY
...The history of Russian first hygienic rules and norms (national safety standard) started at the same time as in USA, and the head of this research program was Z. Gordon. In the USSR, and now in the Russian Federation exposure limits are founded on chronic biological effects caused by non thermal EMF exposures; the effects were investigated using behavioral, electrophysiological, hematological and biochemical methods...

... The Russian approach to exposure assessment and dosimetry has two main differences from those of ICNIRP. First, the concept of SAR was never adopted, because near field measurements were not required until recently. The near field evaluation is performed by computations extrapolating the far field measurement values using theoretical equations. Second, the dosimetry is based on the parameter "power exposition" (PE) which is a dynamic estimate of the EMF biological effects from the exposure. This parameter differentiates the exposure dose during a given time interval.

In other words, the Russian exposure limitations consider cumulative the biological effects of RF EMF. PE values depend on time, field level and frequency range...

...This approach defines a dose-dependent biological action of RF EMF and, so, a dependence of time and intensity of the safe RF exposure...

Chinese Regulatory considerations
Coghill Research Laboratories
Derivation of Exposure Limits for RF/MW in China

http://www.cogreslab.co.uk/china.asp

...There are two regulatory bodies, the Chinese Public Health Ministry (CPHM) and the Chinese Environmental Protection Agency (CEPA). These used different exposure criteria. The former based its ELVs on thermal and non thermal considerations, while the CEPA based its standards on SAR. To cut to the chase, CPHM adopted a 20-fold safety factor reduction over the experimental threshold limit values (TLVs), and decided that 50microWatts/cm2 was the ELV for all microwaves, whereas for **CEPA the limit for long medium and short waves is 5-25 Volts/metre and 10 microWatts/cm2 in areas where there is a requirement for absence of health hazard.** The CEPA SAR limits are 0.1W/kg for occupational exposure (8 hr day, any 6 mins continuously), and 0.02W/kg for general public exposure. (All standards for general public exposure in China are one fifth of the occupational levels.

The derivation of these standards goes back to the 1970s. The first ELVs for microwaves were issued in 1979 by the Chinese Ministry of 4th Machine Industry (CM4MI) as "temporary sanitary rules for workplace"., but these were extended and amended in 1989 by CMPH. CM4MI had carried out during 1975-77 a large cross sectional epidemiological study with a working group including Zhejiang Medical University, Beijing Jiuxian Qiao Hospital and another 15 epidemic preventive stations in factories and institutions.

In this large study four groups were formed, 0, <50,<200, and > 200 microWatts/cm2. The results showed a higher prevalence of neurosis, bradycardia, ST-T level, delayed P and QRS intervals (all greater than 1 second) changes in electrocardiography (ECG) abnormal ECG, disorders of the nervous system, decreased white blood counts (WBC) - less than 5000/mm3, and blood platelets - less than 105/mm3. Vacuoles were noted in the lens of the two groups exposed to the higher radiation levels (a feature also reported in several western studies. e.g. by Milton Zaret). Even the group exposed to less than 50 microWatts/cm2 also reported symptoms of increased neurosis compared with controls.

Acute and subacute experiments were also performed on animals, establishing a TLV of 1mW/cm2. Allowing for a 20-fold safety factor the ELV was therefore set at 300 microWatts/cm2, that is 38microWatts/cm2 for an 8 hour working day.

A similar epidemiologic study was carried out by CMPH. The amended ELV for microwaves was however set at 50 microwatts/cm2 for an 8 hour working day. Thus the ELVs were firmly based on at least two large scale human population health effects studies. By contrast the Western values were derived from a few small acute studies on rodents and small primates. It is obvious to any reasonable person the Chinese conclusions are far more realistically based...

Biological Effects of Radiofrequency Radiation (revised2. February1996)
Cut/condensed from **Biological Effects of Radiofrequency and Microwave Radiation: Application, Hazards, and Safeguards. By Wolfgang W. Scherer (25. March 1994)**

http://www.reach.net/~scherer/p/biofx.htm

- **mW = milli-Watt = 1/thousandth Watt = 10^{-3} Watt**
- **μW = micro-Watt = 1/Millionth Watt = 10^{-6} Watt**
- **nW = nano-Watt = 1/Billionth Watt = 10^{-9} Watt**
- **pW = pico -Watt = 1/Trillionth Watt = 10^{-12} Watt**

... Thermal effects can be measured long before temperature changes are observed. The blood vessels are dilating and the blood flow increases substantially as the thermoregulatory mechanism is activated in order to keep the body temperature constant. With rising body temperature the metabolic rate rises also, what may lead to Stress-Adaptation-Fatigue Syndrome. This may be the thermal explanation for late and cumulative effects of radio-frequency radiation, that other researchers try to explain through non thermal effects of radiation exposure...

What distinguishes radiofrequency introduced heating from other means of heating is the rapidity of heating, the depth of penetration, and the existence of internal hot-spots, that can result in tissue damage long before the overall body temperature increases dramatically. The brain is particularly susceptible to the occurrence of these hot-spots. Depending on the size of the head and the frequency of the radiation, regions of relatively high absorption can occur at or near the center of the brain. These effects are especially uncontrollable in the near-field during the use of mobile communication devices like cordless and cellular phones and very unpredictable due to the variable shape, size, and thickness of skulls.

However, the main objectively measurable hazard of microwave radiation is injury to the eyes, especially damaging at frequencies above 800 MHz. Since the lens of the eye does not have an adequate vascular system for the exchange of heat, even a slight rise in temperature can cause protein coagulation, and opacities in the lens may form...

Resolutions/Warnings and Research Needs

May 31, 2011: International Agency for Research on Cancer (IARC) and World Health Organization (WHO) reclassified radio frequency electromagnetic fields as a Class 2B carcinogen (possibly carcinogen to humans).

http://electromagnetichealth.org/electromagnetic-health-blog/iarc-rf-carc/

2002 letter from the EPA (Environment Protection Agency) stating the FCC's standards are "thermally based, and do not apply to chronic, non-thermal exposure situations"

http://americanassociationforcellphonesafety.org/uploads/noi_epa_response.pdf

President's Cancer Panel: Environmentally caused cancers are 'grossly underestimated' and 'needlessly devastate American lives.'
Publication Date: 6th May 2010 | View full report

The President's Cancer Panel on Thursday reported that "the true burden of environmentally induced cancers has been grossly underestimated" and strongly urged action to reduce people's widespread exposure to carcinogens.
From the report: "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," Schettler said"2009 European Parliament Resolution Health concerns associated with electromagnetic fields

April 2009 European Parliament Committee on the Environment, Public Health and Food Safety voted overwhelmingly to recommend precautions be taken to protect human health with regard to wireless technologies.

http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2009-0216+0+DOC+XML+V0//EN

21.04.2009
The European Parliament's Committee on the Environment, Public Health and Food Safety recently voted overwhelmingly to recommend precautions be taken to protect human health with regard to wireless technologies, such as mobile phones, Wi-Fi/Wi-Max, Bluetooth, DECT portable phones and cell towers That certain establishments be kept free of wireless radiation, including schools, day care centers, retirement homes and health care institutions;
* Recognition that persons with Electrohypersensitivty are 'disabled' so as to assure them protection and equal opportunity under law.
* For member states to create maps of sources of exposure and make them available to citizens on the Internet including description of power line emissions and radiofrequency and microwave radiation;
* That Regional Antenna Plans be integrated into Urban Development Plans; and,
* That Member states create yearly reports on electromagnetic radiation, describing the sources and actions that have been taken to better protect human health and the environment.

January 2008 National Academy of Science Report Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication Devices

http://www.nap.edu/catalog/12036.html

"In January 2008, the National Research Council (NRC), an arm of the National Academy of Sciences and the National Academy of Engineering, issued a report saying that we simply don't know enough about the potential health risks of long-term exposure to RF energy from cell phones themselves, cell towers, television towers, and other components of our communications system. The scientists who prepared the report emphasized, in particular, the unknown risks to the health of children, pregnant women, and fetuses as well as of workers whose jobs entail high exposure to RF (radiofrequency) energy....Because so much of cell phone technology is new and evolving, we don't have data on the consequences of 10, 20 or 30 years worth of exposure to the RF energy they emit," Weil concluded. The report called for long-term safety studies on all wireless devices including cell phones, computers, and cell phone towers.

EMF resolutions signed by concerned scientists and medical doctors

These Resolutions are signed by scientists, engineers and medical doctors who have been doing EMF research and working internationally on electromagnetic fields health and safety. The combination of their training, experience and the many contributions they have made in conducting and publishing, represents hundreds of years of expertise and places them at the forefront of knowledge about EMF.

Vienna Resolution 1998 www.icems.eu/docs/resolutions/Vienna_Resolution_1998.pdf
Salzburg Austria Resolution 2000 http://www.salzburg.gv.at/salzburg_resolution_e.htm
Freiburger Appeal 2002 www.laleva.cc/environment/freiburger_appeal.html
Catania Italy 2002 www.emrpolicy.org/faq/catania.pdf
Benevento Italy Resolution 2006 http://www.icems.eu/benevento_resolution.htm
Venice Italy Resolution 2008 http://www.icems.eu/resolution.htm
Porto Alegre Resolution 2009 http://www.icems.eu/other_res.htm

International Association of Firefighters moratorium of cell tower siting on Fire stations

http://www.iaff.org/hs/Facts/CellTowerFinal.asp

...There is a large body of internationally accepted scientific evidence which points to the existence of non-thermal effects of RF/MW radiation. The issue at the present time is not whether such evidence exists, but rather what weight to give it.

Internationally acknowledged experts in the field of RF/MW radiation research have shown that RF/MW transmissions of the type used in digital cellular antennas and phones can have critical effects on cell cultures, animals, and people in laboratories and have also found epidemiological evidence (studies of communities, not in the laboratory) of serious health effects at "non-thermal levels," where the intensity of the RF/MW radiation was too low to cause heating. They have found:

- Increased cell growth of brain cancer cells (5)
- A doubling of the rate of lymphoma in mice (6)
- Changes in tumor growth in rats (7)
- An increased number of tumors in rats (8)
- Increased single- and double-strand breaks in DNA, our genetic material (9)
- 2 to 4 times as many cancers in Polish soldiers exposed to RF (10)
- childhood leukemia in children exposed to RF (11)
- Changes in sleep patterns and REM type sleep (12)
- Headaches caused by RF/MW radiation exposure (13)
- Neurologic changes (14) including:
  - Changes in the blood-brain-barrier (15)
  - Changes in cellular morphology (including cell death) (16)
  - Changes in neural electrophysiology (EEG) (17)
  - Changes in neurotransmitters (which affect motivation and pain perception) (18)
  - Metabolic changes (of calcium ions, for instance) (19)
  - Cytogenetic effects (which can affect cancer, Alzheimer's, neurodegenerative diseases) (20)
- Decreased memory, attention, and slower reaction time in school children (21)
- Retarded learning in rats indicating a deficit in spatial "working memory" (22)
- Increased blood pressure in healthy men (23)
- Damage to eye cells when combined with commonly used glaucoma medications (24)

Israel bans antennas on residences

http://www.democrats.org.au/docs/2007/Joining_the_Dots11.pdf

Taiwan removes 1500 cell towers near schools

http://www.chinapost.com.tw/taiwan/2007/11/06/129715/1500-cellphone.htm

Local Government Resolutions (U.S.)

http://www.cloutnow.org/localres/

Los Angeles, California
The Los Angeles County Board of Supervisors voted unanimously on Tuesday, June 2, 2009, to "actively seek and support federal legislation to repeal limitations on state and local authority imposed by the Telecommunications Act of 1996 that infringe upon the authority of local governments to regulate the placement, construction, and modification of telecommunications towers and other personal wireless services facilities on the basis of the health and environmental effects of these facilities."

Tucson, Arizona
The Pima County Board of Supervisors passed a resolution on August 4, 2009, calling "for the U.S. Congress and the Obama administration to repeal Section 704 of the Federal Telecommunication Act of 1996, and otherwise let local jurisdictions control fully the siting, construction and installation of wireless communications facilities in order to ensure that their constituents' environment, health and safety are protected from the potentially damaging effects of electromagnetic radiation."
Sebastopol City Council
The City Council of Sebastopol, California, passed a resolution on July 7, 2009, instructing the City's legislative advocates "to actively seek and support federal legislation to repeal limitations on state and local authority imposed by the Telecommunications Act of 1996 that infringe upon the authority of local governments to regulate the placement, construction, and modification of telecommunications towers and other wireless facilities on the basis of the health and environmental effects of these facilities."
Glendale, California
The City Council of Glendale, California, passed a resolution on June 9, 2009, directing the City staff "to have its federal legislative advocates communicate to the U.S. Congress, the President and executive branch members to: (1) actively seek and support federal legislation that would give local governments greater flexibility to regulate the placement of wireless communications facilities given the unique aesthetic and safety issues that said facilities raise and to regulate such facilities in favor of less intrusive and more efficient technologies; (2) urge that the federal government engage in a comprehensive study of the effects of Wireless facilities RF emissions to assess the health impacts of these emissions; and (3) to review and revise those provisions of the Telecommunications Act of 1996, including but not limited to Section 332(c)(7)(B), that limit or compromise the rights of local zoning authorities to govern over the placement, construction and modification of wireless communications facilities on the basis of environmental effects of radio frequency emissions, until all environmental exposures are cumulatively considered."
Portland City Council
The City Council of Portland, Oregon, passed a resolution on May 12, 2009, requesting "the FCC to work in cooperation with the FDA and other relevant federal agencies to revisit and update studies on potential health concerns arising from RF wireless emissions in light of the national proliferation of wireless use."
Albany, California
The City Council of Albany, California, passed a resolution on July 20, 2009, requesting "the FCC to work in cooperation with the FDA and other relevant federal agencies to revisit and update studies on potential health concerns arising from RF wireless emissions in light of the national proliferation of wireless use."
Agoura Hills, California
The City Council of Agoura Hills, California, passed a resolution on December 9, 2009, that "Urges Congress to initiate and pursue legislation to repeal those sections of the 1996 Telecommunications Act that preempt local control and prevent local governments from considering health effects when deciding whether to approve a wireless communications facility... Informs the California Public Utilities Commission (CPUC) that the City opposes the unrestricted use of rights of way for wireless telecommunications facilities."
Santa Barbara, California
The Santa Barbara County Board of Supervisors passed a resolution on November 10, 2009, that states, "There is ongoing debate within the scientific community regarding how thoroughly the long-term health effects of low-frequency electromagnetic and radio-

frequency emissions are understood and questions regarding how well the existing regulations established by the Federal Communications Commission [FCC] protect more vulnerable populations such as school-aged children..." The resolution urges the County's Congressional representatives to initiate and pursue legislation to repeal the health pre-emption in the Telecommunications Act of 1996, and opposes the unrestricted use of right-of-ways for wireless facilities.

Action on Smart Meters

EMF Safety Network has:

http://emfsafetynetwork.org/?page_id=872

The Utility Reform Network, State Senator Dean Florez, the City and County of San Francisco, Santa Cruz and Marin County Board of Supervisors, Sonoma County Supervisor Efren Carrillo, the cities of Sebastopol, Berkeley, San Rafael, Cotati, Fairfax, Santa Cruz, Piedmont, Scotts Valley, Capitola, Watsonville, Sausalito, San Anselmo, Belvedere, Monte Sereno, Novato, Richmond, Ross, Bolinas, Camp Meeker, the Peace and Freedom Party, the Marin Association of Realtors, the Sonoma County Republican Central Committee, and The EMF Safety Network are calling for a moratorium, a ban, or are opposing Smart Meters. In addition three cities in the State of Maine have passed resolutions calling for a moratorium on Smart Meters.

Scarborough, Maine asks CMP to postpone installation of smart meters
http://www.pressherald.com/news/Scarborough-asks-CMP-to-postpone-installation-of-smart-meters.html

Chicago area court halts smart meter program
http://www.suntimes.com/business/2816920,comed-smart-meter-program-hold-101910.article

Los Angeles Unified School District May 26, 2009 Resolution on Wireless Telecommunication Installations

http://www.cloutnow.org/

...Whereas, On June 27, 2000 and May 26, 2009, the Governing Board of the Los Angeles Unified School District adopted resolutions opposing the siting of cellular facilities on or in close proximity to schools to ensure individuals, especially children, are protected from the potential health effects associated with exposures to extremely low frequency electromagnetic and radiofrequency radiation;
Whereas, The District has been successful in restricting the placement of wireless communication installations on its school facilities, but it has had limited success in preventing wireless service facilities from siting near its schools due to apparent restrictions placed upon zoning authorities to consider the health and environmental effects of radio-frequency radiation;

Whereas, The desire of the wireless companies to market new wireless services has since led to a proliferation of cellular facilities targeting residential areas and areas near schools;
Whereas, Wireless infrastructure is being deployed at an unprecedented speed and cellular facilities have been approved without proper justification and proof that the placement is to serve existing demand or provide public safety benefits;
Whereas, Serious concerns exist regarding wireless permits approved near schools without proper notification to school officials and nearby property owners or proper review and oversight of the wireless applications;
Whereas, Cities, counties, and local municipalities have relied upon Section 704 of the Federal Telecommunications Act of 1996 to preempt local communities and school districts from opposing the placement, construction, and modification of personal wireless service facilities on the basis of environmental effects of radio-frequency emissions to the extent that the proposed facilities comply with the Federal Communications Commission regulations concerning such emissions;...

Hempstead, New York Telecommunications Ordinance

http://toh.li/content/home/news/telecomlaw.html

Requires a Special Use Permit for Distributed Antenna Systems within 1,500 from residential property boundaries, house of worship, day care centers and schools.

West Lin-Wilsonville School Board in Oregon Prohibits Cell Towers on and adjacent to school property

http://www.momsforsaferwireless.org/Cell-Phone-Towers-and-Antennas-on-School-Property.php

In 2008 the West Lin-Wilsonville School Board in Oregon voted to prohibit commercial microwave cell sites on and adjacent to school property. The School Board allows the one existing cell tower contract to expire. Board members were concerned that the cell sites were not proven safe.

Communities and Groups Vote for Tower Setbacks from Schools and Daycare Facilities

http://centerforsaferwireless.org/Cell-Phone-Towers-and-Antennas-on-School-Property.php

Greenwich, CT generated a bill to require a 750 square setback of cell towers from schools and daycare facilities.

The Connecticut PTA passed a resolution in 2003 that supports legislation calling for a 1500 feet setback from a school or day care and a cell phone tower.

The town of Bar Harbor, Maine includes in its communication tower ordinance a provision for a 1,500 feet setback for cell towers near schools and day care facilities.

Epidemiological evidence

Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

http://rparticle.web-p.cisti.nrc.ca/rparticle/RpArticleViewer?_handler_=HandleInitialGet&journal=er&volume=18&calyLang=eng&media=html&articleFile=a10-018.pdf

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Received 30 April 2010. Accepted 6 August 2010. Published on the NRC Research Press Web site at http://er.nrc.ca on 5 November 2010.

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.PowerWatch UK Database of Cell Tower Studies

Powerwatch UK Database – 26 out of 44 Peer Reviewed Studies Show Significant Health Risks

http://www.powerwatch.org.uk/science/studies.asp (Please scroll down to the section on Mobile Phone Masts, the term for Cell Towers in the UK)

26 out of 44 epidemiological studies they found to meet their criteria show significant health risks.

WHO Database - 10 Out of 14 Peer Reviewed Studies Found Significant Health Symptoms

http://www.scribd.com/doc/11484728/10-Out-of-14-Peer-Reviewed-Studies-Found-Significant-Health-Symptoms

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TBB-4VRWNH1-2&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=b22f07bbd6f4e2076bdc07dbc4e94df6

Review of 14 studies collected from the WHO database and put together by Michael Kundi, a, and Hans-Peter Huttera. 10 out of the 14 peer-reviewed studies analyzed, and conforming to the specified WHO / ICNIRP standards of scientific quality, including their assessment criteria of consistency and replication found significant increases in ill health effects. Included in this database are only those studies that are about cell tower exposures. (Kundi, 2008 at the London EMF International Conference). Populations close to cellular antennas show an increase in the effects of ill health in those closest to the antennas with the risks factors dropping off as distance and RFR levels decrease. Symptoms range from sleeps disturbances to breast and brain cancers.

DEC/JAN 2008 issue of The Ecologist report on the health impacts of wireless transmissions. The following peer-reviewed studies on health effects from cell towers ("mobile phone masts" in U.K. parlance) and other sources of RF radiation were included in the report.

http://www.theecologist.org/

Santini et al., 2002: 530 people living near to mobile phone masts reported more symptoms of headache, sleep disturbance, discomfort, irritability, depression, memory loss, and concentration problems the closer they lived to the mast.
Oberfeld et al., 2004: 97 people living near to mobile phone masts reported more symptoms of fatigue, irritability, headaches, nausea, loss of memory, visual disorder, dizziness and cardiovascular problems the higher their level of microwave exposure.
Eger et al., 2004: A three-fold increase in the incidence of malignant tumours was found after 5 years exposure in people living 400 metres from a mobile phone mast.
Wolf & Wolf, 2004: A four-fold increase in the incidence of cancer among residents living near a mobile phone mast for between 3 and 7 years was detected.
REFLEX, 2004: A four year study on human cells found that, after exposure to low-power microwaves, the cells showed signs of DNA damage and mutations which were passed on to the next generation.
Abdel-Rassoul, 2007: Residents living under and opposite a long-established mobile phone mast in Egypt reported significantly higher occurrences of headaches, memory

changes, dizziness, tremors, depressive symptoms and sleep disturbance than a control group.
Bortkiewicz et al., 2004: Residents close to mobile phone masts report more incidences of circulatory problems, sleep disturbances, irritability, depression, blurred vision, and concentration difficulties the nearer they live to the mast.
Hutter et al., 2006: 365 people living near to mobile phone masts reported higher incidences of headaches the greater the closer they lived to the masts.
Stewart report, 2000: Research conducted by HPA [Health Protection Agency, UK] chief William Stewart advised that the main beam of a mobile phone mast should not be allowed to fall on any part of a school's grounds.
Hecht & Balzer, 1997: A huge review of studies which concluded a vast array of health effects, including insomnia, changes in brain-wave activity, cardiovascular problems and increased susceptibility to infections.
Carpenter & Sage, 2007: Conclude that an outdoor maximum exposure limit of 0.6 V/m should be set, and that Wi-Fi systems should be replaced with wired alternatives
ECOLOG-Institut, 2000: Found evidence for increases in immune system damage, central nervous system damage, and reduced cognitive function. Recommends an exposure limit 1000 times lower than current guidelines.
Kolodynski & Kolodynska, 1999: School children living near a radio location station in Latvia suffered reduced motor function, memory and attention spans.

Studies on Low Level Non Thermal Biological Effects of EMF/RF

Non Thermal Effects and Mechanisms of Interaction 2010
National Institute for Prevention and Safety at Work (ISPESL), Rome, Italy

http://dl.dropbox.com/u/11443525/An%20ICEMS%20Monograph%202010.pdf

BioInitiative Report August 2007

http://www.bioinitiative.org/

(See also - Sage C, Carpenter DO. 2009. Public health implications of wireless technologies, Pathophysiology Aug; 16(2-3): 233-46)
Pathophysiology (2009) Electromagnetic Fields in Biology and Medicine. Vol. 7, No. 2.

http://www.elsevier.com/wps/find/journaldescription.cws_home/524214/description#description
http://www.journals.elsevierhealth.com/periodicals/ymem/article/PIIS0196064405007110/related?article_id=S0196-0644%2805%2900711-0

European Union's REFLEX Project
(Risk Evaluation of Potential Environmental Hazards from Low Frequency Electromagnetic Field Exposure Using Sensitive in vitro Methods),
November 2004. The Project studied ELF and RF exposures to various animal cell types.

http://www.itis.ethz.ch/downloads/REFLEX_Final%20Report_171104.pdf

The twelve partners conducted experiments on human, rat and mouse cells of various types. Roughly half of those experiments used RF (RadioFrequency) EMFs, as emitted by mobile phones and masts; the other half used ELF (Extremely Low Frequency) EMFs as emitted from power lines and similar sources. Both types of emission were shown to have a number of significant effects on the behavior of cells.

Conclusions based on the findings obtained in RF EMF research" listed in the REFLEX Report:

"RF-EMF produced genotoxic effects in fibroblasts, Cells responded to RF-EMF exposure with a significant increase in single and double strand DNA breaks and in micronuclei frequency Chromosomal aberrations in fibroblasts were also observed after RF-EMF exposure. In HL-60 cells an increase in the intracellular generation of free radicals accompanying RF-EMF exposure could clearly be demonstrated
"There is some indication that RF-EMF may have some influence on the bcl-2 mediated anti-apoptotic pathway in neural progenotor cells and on the p38MAPK/hsp27 stress response pathway in endothelial cells of human which may in turn exert an inhibitory effect on apoptosis."

Note: 'apoptosis' is 'programmed cell death' - the body's defense mechanism that kills off cells that are malformed or running out of control, a natural protection against possibly cancerous cells..

Reported Biological Effects From Radiofrequency Non-Ionizing Radiation

http://www.wave-guide.org/library/studies.html#std

The following studies indicate biological effects at exposure levels far below what would be explained by "thermal effects", and well within the range people are commonly exposed to every day. NOTE: Most of these exposures lie FAR BELOW the current advisory exposure standards in the US, which are based on thermal effects only.

Havas, M. 2007. Analysis of Health and Environmental Effects of Proposed San Francisco Earthlink Wi-Fi Network. Sent to Board of Supervisors, City and County of San Francisco, May 31, 2007, 51 pp.

http://www.magdahavas.org/2009/10/10/san-francisco-wi-fi-and-health/

Dr. Henry Lai (University of Washington) compiled a list of studies that document biological effects of radio frequency radiation at low intensities (Table 2).

Radio Wave Packet by. ARTHUR FIRSTENBERG. President, Cellular Phone Taskforce. September 2001. Contents. 1. Some Biological Effects of Radio Waves

www.goodhealthinfo.net/radiation/radio_wave_packet.pdf

Firstenberg (6) also compiled a list of studies showing biological effects at levels below federal guidelines for radio frequency radiation

Havas, M., J. Marrongelle, B. Pollner, E. Kelley, and L. Tully. Provocation Study using Heart Rate Variability shows Microwave Radiation from DECT phone affects Autonomic Nervous System.
Journal of the Ramazzini Institute, Annual Series on Environmental Health Issues, Italy, submitted.

http://www.magdahavas.org/list-of-publications/

2008 MOBILE TELEPHONY RADIATION EFFECTS ON LIVING ORGANISMS
Dimitris J. Panagopoulos* and Lukas H. Margaritis
Department of Cell Biology and Biophysics, Faculty of Biology, University of Athens, Panepistimiopolis, 15784, Athens, Greece

http://tinyurl.com/24wjaug
http://kyttariki.biol.uoa.gr/EMR-GROUP/Panagopoulos-Margaritis-review-2008.pdf

Abstract
A number of serious non thermal biological effects, ranging from changes in cellular function like proliferation rate changes or gene expression changes to cell death induction, decrease in the rate of melatonin production and changes in electroencephalogram patterns in humans, population declinations of birds and insects, and small but statistically significant increases of certain types of cancer, are attributed in our days to the radiations emitted by mobile telephony antennas of both handsets and base stations. This chapter reviews briefly the most important experimental, clinical and statistical findings and presents more extensively a series of experiments, concerning cell death induction on a model biological system....

Conclusion
...Digital mobile telephony radiations nowadays exert an intense biological action able to kill cells, damage DNA, or decrease dramatically the reproductive capacity of living organisms. Diminishes of bird and insect populations can be explained according to reproduction decreases. Phenomena like headaches, fatigue, sleep disturbances, memory loss e.t.c. reported as "microwave syndrome" can possibly be explained by cell death on a number of brain cells during daily exposures from mobile telephony antennas...

...Scientific evidence implies the need of reconsideration of the current exposure criteria to account for non-thermal effects which constitute the large majority of the recorded biological and health effects. Since Mobile Telephony has become part of our daily life, a better design of base station antenna networks towards the least exposure of residential areas and a very cautious use of mobile phones, is necessary.

http://www.ncbi.nlm.nih.gov/pubmed/6473704,3353493,8442779,7980658,8313501,10757046,10757053,11424153

1. Clastogenic effects in human lymphocytes of power frequency electric fields: in vivo and in vitro studies.
Nordenson I, Mild KH, Nordström S, Sweins A, Birke E.
Radiat Environ Biophys. 1984;23(3):191-201.
PMID: 6473704 [PubMed - indexed for MEDLINE]
Related citations

2. Chromosomal effects in lymphocytes of 400 kV-substation workers.
Nordenson I, Mild KH, Ostman U, Ljungberg H.
Radiat Environ Biophys. 1988;27(1):39-47.
PMID: 3353493 [PubMed - indexed for MEDLINE]
Related citations

3. Rat liver foci study on coexposure with 50 Hz magnetic fields and known carcinogens.
Rannug A, Holmberg B, Ekström T, Mild KH.
Bioelectromagnetics. 1993;14(1):17-27.
PMID: 8442779 [PubMed - indexed for MEDLINE]
Related citations

4. Chromosomal aberrations in human amniotic cells after intermittent exposure to fifty hertz magnetic fields.
Nordenson I, Mild KH, Andersson G, Sandström M.
Bioelectromagnetics. 1994;15(4):293-301.
PMID: 7980658 [PubMed - indexed for MEDLINE]
Related citations

5. Intermittent 50 Hz magnetic field and skin tumor promotion in SENCAR mice.
Rannug A, Holmberg B, Ekström T, Mild KH, Gimenez-Conti I, Slaga TJ.
Carcinogenesis. 1994 Feb;15(2):153-7.
PMID: 8313501 [PubMed - indexed for MEDLINE]
Related citations

6. DNA damage, cell kinetics and ODC activities studied in CBA mice exposed to electromagnetic fields generated by transmission lines.
Svedenstål BM, Johanson KJ, Mattsson MO, Paulsson LE.
In Vivo. 1999 Nov-Dec;13(6):507-13.
PMID: 10757046 [PubMed - indexed for MEDLINE]
Related citations

7. DNA damage induced in brain cells of CBA mice exposed to magnetic fields.
Svedenstål BM, Johanson KJ, Mild KH.
In Vivo. 1999 Nov-Dec;13(6):551-2.
PMID: 10757053 [PubMed - indexed for MEDLINE]
Related citations

8. Chromosomal aberrations in peripheral lymphocytes of train engine drivers.
Nordenson I, Mild KH, Järventaus H, Hirvonen A, Sandström M, Wilén J, Blix N, Norppa H.
Bioelectromagnetics. 2001 Jul;22(5):306-15.
PMID: 11424153 [PubMed - indexed for MEDLINE]
Related citations

In Vivo. 1999 Nov-Dec;13(6):507-13.
DNA damage, cell kinetics and ODC activities studied in CBA mice exposed to electromagnetic fields generated by transmission lines.
Svedenstål BM, Johanson KJ, Mattsson MO, Paulsson LE.
Department of Radioecology, Swedish University of Agricultural Sciences, Uppsala, Sweden.
svedenstal@delta.telenordia.se
Abstract
CBA mice were exposed outdoors to 50 Hz electromagnetic fields (EMF), with a flux density of about 8 microT rms (root mean square), generated by a 220 kV transmission line. Assays were performed in order to investigate, the possible genotoxic effects after 11, 20 and 32 days of exposure, as well as the effects on body weight, leukocytes, erythrocytes, and the level of ornithine decarboxylase (ODC) activity in spleen and testis. DNA migration was studied on brain cells by single cell electrophoresis (comet assay). After 32 days of exposure a highly significant change of the tail/head ratio of the comets was observed ($p < 0.001$), showing DNA-damage. Further, a decreased number of mononuclear leukocytes ($0.02 < p < 0.05$) was observed in mice EMF-exposed for 20 days. In summary, our data indicate that transmission lines of this type may induce genotoxic effects in mice, seen as changes in the DNA migration. These results might have an important implication for health effects.
PMID: 10757046 [PubMed - indexed for MEDLINE]
Publication Types, MeSH Terms, Substances

http://www.ncbi.nlm.nih.gov/pubmed/10757046

Mutat Res. 2010 Jan 5;683(1-2):74-83.
DNA fragmentation in human fibroblasts under extremely low frequency electromagnetic field exposure.
Focke F, Schuermann D, Kuster N, Schär P.
Institute of Biochemistry and Genetics, Department of Biomedicine, University of Basel, Basel, Switzerland.
Abstract
Extremely low frequency electromagnetic fields (ELF-EMFs) were reported to affect DNA integrity in human cells with evidence based on the Comet assay. These findings were heavily debated for two main reasons; the lack of reproducibility, and the absence of a plausible scientific rationale for how EMFs could damage DNA. Starting out from a replication of the relevant experiments, we performed this study to clarify the existence and explore origin and nature of ELF-EMF induced DNA effects. Our data confirm that intermittent (but not continuous) exposure of human primary fibroblasts to a 50 Hz EMF at a flux density of 1 mT induces a slight but significant increase of DNA fragmentation in the Comet assay, and we provide first evidence for this to be caused by the magnetic rather than the electric field. Moreover, we show that EMF-induced responses in the Comet assay are dependent on cell

proliferation, suggesting that processes of DNA replication rather than the DNA itself may be affected. Consistently, the Comet effects correlated with a reduction of actively replicating cells and a concomitant increase of apoptotic cells in exposed cultures, whereas a combined Fpg-Comet test failed to produce evidence for a notable contribution of oxidative DNA base damage. Hence, ELF-EMF induced effects in the Comet assay are reproducible under specific conditions and can be explained by minor disturbances in S-phase processes and occasional triggering of apoptosis rather than by the generation of DNA damage.
PMID: 19896957 [PubMed - indexed for MEDLINE]

http://www.ncbi.nlm.nih.gov/pubmed/19896957

International Guidance Levels

Guidelines, exposures and effects of radio frequency radiation at various power densities. Data from Firstenberg (6). (Page 4 and 5)

http://www.magdahavas.org/wordpress/wp-content/uploads/2009/10/07_Havas_WiFi-SNAFU.pdf

Radio frequency guidelines vary by orders of magnitude in countries around the world (See Figure 1).
The FCC guideline ranges from 200 to 1000 microW/cm2 based on frequency and is much higher than the guidelines recommended in New Zealand, Italy, China, Bulgaria, Hungary, Russia, Switzerland, Austria and in New South Wales, Australia. Since the science upon which these guidelines are based remains the same, one way of interpreting this discrepancy is that some countries place a greater value on science and on preventative health regulations while others may place a greater value on commerce.
A number of adverse health effects have been documented at levels below the FCC guidelines, which include altered white blood cells in school children; childhood leukemia; impaired motor function, reaction time, and memory; headaches, dizziness, fatigue, weakness, and insomnia. At the frequency in question for Wi-Fi technology the guideline in the US is 1000 microW/cm2 (or 1 milliW/cm2).
The current federal guideline is based on a short-term heating effect set at 6-minutes for those occupationally exposed and 30 minutes for public exposure. An FCC guideline based on a 30-minute exposure is unrealistic for exposure that is likely to be 24/7 for decades. However, if this guideline is extrapolated for long-term exposure, the exposure limit decreases and approaches guidelines established by other countries (Table 1).
According to Table 1, if the goal is to protect people who use a wireless computer daily for one year, their exposure should not exceed 0.33 microW/cm2 (a value similar to the Salzburg guideline) and to protect them for 10 years their exposure should not exceed 0.03 microW/cm2

International Guidance Levels

http://www.powerwatch.org.uk/science/intguidance.asp

EMF/RF Limits for Maximum Permissible Exposures

http://pcbheaven.com/blogpages/To_WiFi_or_not_to_WiFi/

RFR Standards and Measurements Over Time

www.bioinitiative.org

Section 20

Original extra-planetary sources of microwave radiation were infinitesimally small, on the order of a billionth of a microwatt per centimeter squared (10^{-12} uW/cm^2). Human evolution took place without any appreciable exposure to microwave radiation from background sources. The human body has no evolutionary protection against microwave radiation, as it does for ultraviolet radiation from the sun (Johannson, 2000). Wireless voice and communications have introduced unprecedented levels of public exposure in the last decade.

Mantiply (1997) measured and reported common sources and levels of RF in the environment. He identified areas near cellular base stations on the ground near towers to be from 0.003 to 0.3 μW/cm^2. Background level ambient RF exposures in cities and suburbs in the 1990's were generally reported to be below 0.003 μW/cm^2.

Hamnerius (2000) reported that ambient RF power density measurements in twelve (12) large cities in Sweden were roughly ten times higher than in the United States for equivalent measurement locations by Mantiply in 1978 (when no cellular phone service existed in the US). He reported a total mean value of 26 measured sites in the study was 0.05 μW/cm^2 and the median value was 40 μ/cm2. An office location with a base station nearby at about 300 feet distance tested 150 μ/cm^2. A train station with antennas mounted indoors tested at about 3 μW/cm^2. Both indoor and outdoor ambient RF power density measurements showed high variability depending on proximity to transmitting antennas.

Sage Associates reported on microwave frequency RF power density levels at outdoor locations both near and far from wireless antenna sites in the United States (Sage, 2000).

Within the first 100-300 feet, power density levels have been measured at 0.01 to 3.0 μW/cm^2. Elevated RF power density levels from a major wireless antenna site can often be detected at 1000 feet or more. Power density levels away from wireless antenna sites measure between 0.001 μ/Wcm^2 to 0.000001 μW/cm^2

Limit exposure to mobile phones: French experts
Publication Date: 16th October 2009 | View original on BreitBart

http://www.senat.fr/rap/l08-552-1/l08-552-1102.html Translation http://tinyurl.com/2azgmmm

French health watchdogs, in a precautionary move, recommended on Thursday reducing exposure to mobile phones and other portable wireless devices. The guidelines are an interim

step pending the outcome of wider research into any impacts from health from radio frequency fields.
"The time for inaction has passed," Martin Guespereau, director of the French Health and Security Agency (Afsset), said at a press conference. "Let's not wait until the indications become pathologies before moving forward with limiting exposure," he said.
More than 1,000 studies were reviewed by Afsset, focussing on mobile phones, Wifi emitters, microwave ovens, cordless home phones and other gadgets that use frequencies of between 9 kilohertz (kHz) and 300 gigahertz (gHz).
Most of the studies did not show any negative impacts. Some research, however, did point to possible health problems, including cell damage, reduced male fertility and a lower blood flow to the brain.
Emphasising caution, Guespereau also pointed out that cellphones have been widely used for barely a decade, not long enough to study long-term impacts from constant exposure. "We cannot endorse the idea 'nothing has been proved, so nothing needs to be done'," said Guespereau.

The Federal Assembly of the Swiss Parliament
November 2010

www.next-up.org/.../Swiss_Parliament_To_reduce_the_level_of_exposure_to_non_ionizing_radiation_22_07_2009.pdf

The Federal Assembly of the Swiss Parliament has received a proposed bill from Parliament Member Christian Van Singer (Bill 09438) to:

1. 1. To give consumers the possibility of choosing products that emit a low level of electromagnetic radiation. To achieve this the law should institute the obligation to indicate the level of radiation emitted on all mobile telephones, cordless phones and their base stations, and on other products that cause irradiation as well as in the advertising that recommends them;

2. 2. To give local authorities the power to designate areas with a low level of radiation with limits that that are ten times lower that those currently permitted by ORNI and to impose on mobile telephone operators for example emission levels that do not exceed 0.3 volts per meter, as in the region of Salzburg;

3. 3. To forbid the installation of antennas in proximity to nurseries, schools, and other sensitive places.

For full text see:
- Swiss Federal Parliament: Bill proposed by 54 MPs
- "Reduce the level of exposure to non-ionizing radiation"
- Demand for the creation of refuge zones of 0.3 V/m for the EHS, and for banning relay antennas close to schools and other sensitive places.

Monaco institutes a threshold electric field of 6 V / m for emissions of radio antenna, television, walkie talkie, wireless, with a constraint that can drop by the place of issue at 4 volts / meter for mobile phone masts.

http://www.gouv.mc/304/wwwnew.nsf/1909$/9828072B9325685EC12577EE0051B065FR?OpenDocument&1Fr

The state oversees Monaco emissions of electromagnetic waves

3-12-2010 -

The Sovereign Order No. 3020 of 26 November 2010, published in the Journal of Monaco, now regulates strictly the field emission of electromagnetic waves.

"The emission of electromagnetic waves, including those of mobile phones are one of the legitimate concerns that arise regularly to each and everyone.To respond, the Government has decided to regulate on the issue by setting limits for public exposure to electromagnetic fields, "said Gilles Tonelli, Government Counsellor for Facilities, Environment and Urban Planning. He added: "The standards used are stricter than those generally in force."

"The Government has drawn on the most stringent regulations on the subject, like Switzerland," says Marie-Pierre Gramaglia, Director of Electronic Communications. She adds, "we wanted to go further by imposing a threshold electric field of 6 V / m for emissions of radio antenna, television, walkie talkie, wireless, with a constraint that can drop by the place of issue at 4 volts / meter for mobile phone masts. "

The recommendations are generally observed in Europe of 28 volts / meter for FM radio and vary between 40 and 60 volts / meter for mobile telephony.
The state departments closely monitor compliance with the limits in campaigns and annual measurements during the commissioning of a new mobile radio site.

All operators must strictly observe course these limits.

Contact:
Directorate of Electronic Communications
Tel. : (+377) 98 98 88 00

Warnings for children

http://thepeoplesinitiative.org///Home_Page.html

The following countries have issued warnings and precautionary measures regarding cell phones and children. This is an incomplete list and ever changing. It is not kept up to date and these recommendations may change with the politics of the country, the UK being a classic example of that

Indian Government Urges Cautions for Children and Pregnant Women http://us.oneworld.net/article/indian-government-cautions-against-ill-effects-mobile-phones

Germany, Frankfurt - Bans WIFI in the Classroom in Fear of Health Effects...Bavarian Parliament Recommends the Same
http://omega.twoday.net/stories/3974159/

Israel - No use in children under 12 years of age

Russia - General limitation; no use under 12 years

France - No long calls, no use under 16, banning of advertising to children under 12, mandatory earphones with all cell phones
http://www.next-up.org/pdf/FranceNationalLibraryGivesUpWiFi07042008.pdf

Japan - General limitation under 18 years of age

United Kingdom - General limitation under 12 years of age

Toronto's public health department has recommended children under eight should use a cell phone only in emergencies.

Health warnings for children and the use of WIFI in the classroom have also recently arisen out of Germany.

Short summaries of wireless actions regarding children, schools and libraries by:

http://wiredchild.org/government-alias.html

The UK Chief Medical Officers
The European Parliament
The German government's health protection agency
The French government
The Russian National Committee on Non-Ionizing Radiation Protection
The Indian Ministry of Telecommunication
The Israeli Ministry of Health
The Finnish Radiation and Nuclear Safety Authority (STUK)
The International Commission for Electromagnetic Safety (ICEMS)
The Education Profressionals Union
Association of Teachers and Lecturers
The German Teacher's Union for Education and Knowledge
Public Health Department of Salzburg
The Austrian Medical Assoication
Lakehead, University, Canada
Libraries in France
The Progressive Librarian's Guild

Advocacy Groups in U.S. (Sites in addition to the sites referred to above.)

http://emrpolicy.org/
http://electromagnetichealth.org
http://www.microwavenews.com
http://www.antennafreeunion.org
http://emfsafetynetwork.org/
http://centerforsaferwireless.org/
http://www.cell-out.org/
http://www.prove-it.co/

Advocacy Groups for Children

http://safeschool.ca/
http://www.expelcelltowers.org/
http://www.wiredchild.org
http://www.wifiinschools.org.uk.
http://respectpdx.org/index.aspx

Prominent EMF/RF Researchers

http://bemri.org/archive/hese-uk/en/heseuk/who.php
http://bemri.org/archive/hese-uk/en/niemr/scientists.php
http://www.neilcherry.com/
http://www.youtube.com/watch?v=a6wLFeIrCtU
http://www.physiology.columbia.edu/MartinBlank.html
http://ki.se/ki/jsp/polopoly.jsp?d=21984&a=54583&l=en

RFR Impacts on Nature

The Birds, Bees and Mankind, Destroying Nature with EMF/RFR

http://www.kompetenzinitiative.net/britannien/
Brochure Series download
http://broschuerenreihe.net/britannien-uk/brochure/bees-birds-and-mankind/index.html

Electrosensitivity

Three U.S. Governors declared May 2009/10 Electromagnetic Hypersensitivity Awareness Month (Refer to EMS and EHS proclamations)

http://www.americanchronicle.com/articles/view/102653

Advocacy site for Electrosensitive People

www.electrosensitivity.org

Study Bias/Legal

Study bias Report, RFR researcher Dr. Henry Lai, PhD, and Louis Slesin, editor of Microwave News

http://www.microwavenews.com/RR.html

The American Trial Lawyer Fall 2008
Illusion & Escape – The Cell Phone Disease Quagmire. Are We Being Deceived?
By Dr. George L. Carlo

http://d.scribd.com/docs/3zkxbnq025hwwnvgmqm.pdf

Cell Phone Report

Cellphones and Brain Tumors. 15 Reasons for Concern. Science, Spin and the Truth Behind Interphone. August 2009

http://www.radiationresearch.org/pdfs/reasons_us.pdf

Supplemental Images

a. Electromagnetic Spectrum - http://www.astrosurf.com/luxorion/Radio/spectrum-radiation.png

b. RFR absorption in adult Vs child -
http://beyondcreativity.blogs.com/photos/uncategorized/2008/09/14/om_gandhi_penetration_of_radiatio_2.jpg
(Source http://www.ncbi.nlm.nih.gov/pubmed/12117757)

For updates/revision to this report please see online version: **CELL TOWERS AND WIRELESS COMMUNICATIONS – LIVING WITH RADIOFREQUENCY RADIATION** - http://www.scribd.com/doc/24352550/Cell-Tower-Rpt

Note: All web links active as of 10/6/10. If a link does not work, try either pasting the address into the search engine and searching or search for the name of the report.

Please report broken links to angelaflynn80@msn.com

Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.

Key words: radiofrequency radiation (RFR), antenna arrays, cellular phone base stations, microwave sickness, nonionizing electromagnetic fields, environmental pollution.

Résumé : La localisation des stations de base pour téléphones cellulaires et autres infrastructures cellulaires, comme les installations d'antennes sur les toitures, surtout dans les quartiers résidentiels, constitue un sujet litigieux d'utilisation du territoire. La résistance locale de la part des résidents et propriétaires fonciers limitrophes repose souvent sur les craintes d'effets adverses pour la santé, en dépit des réassurances venant des fournisseurs de services de télécommunication, à l'effet qu'ils appliquent les standards internationaux d'exposition. En plus de rapports anecdotiques, certaines études épidémiologiques font état de maux de tête, d'éruption cutanée, de perturbation du sommeil, de dépression, de diminution de libido, d'augmentations du taux de suicide, de problèmes de concentration, de vertiges, d'altération de la mémoire, d'augmentation du risque de cancers, de trémulations et autres effets neurophysiologiques, dans les populations vivant au voisinage des stations de base. Les auteurs révisent ici les études existantes portant sur les gens, vivant ou travaillant près d'infrastructures cellulaires ou autres études pertinentes qui pourraient s'appliquer aux expositions à long terme à la radiation de radiofréquence de faible intensité « RFR ». Bien que la recherche épidémiologique spécifique dans ce domaine soit rare et contradictoire, et que de telles expositions soient difficiles à quantifier compte tenu des degrés croissants du bruit de fond des RFR provenant de produits de myriades de consommateurs personnels, il existe certaines recherches qui justifient la prudence dans l'installation des infrastructures. Les futures études épidémiologiques sont nécessaires afin de prendre en compte la totalité des expositions à la RFR ambiante. Les symptômes rapportés jusqu'ici pourraient correspondre à la maladie classique des micro-ondes, décrite pour la première fois en 1978. Les champs électromagnétiques non-ionisants constituent les formes de pollution environnementale croissant le plus rapidement. On peut effectuer certaines extrapolations à partir de recherches autres qu'épidémiologiques concernant les effets biologiques d'expositions à des degrés bien au-dessous des directives internationales.

Mots-clés : radiofréquence de faible intensité « RFR », les installations d'antennes, des stations de base pour téléphones cellulaires, la maladie classique des micro-ondes, les champs électromagnétiques non-ionisants, pollution environnementale.

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1. Introduction

Wireless technologies are ubiquitous today. According to the European Information Technology Observatory, an industry-funded organization in Germany, the threshold of 5.1 billion cell phone users worldwide will be reached by the end of 2010 — up from 3.3 billion in 2007. That number is expected to increase by another 10% to 5.6 billion in 2011, out of a total worldwide population of 6.5 billion.[2] In 2010, cell phone subscribers in the U.S. numbered 287 million, Russia 220 million, Germany 111 million, Italy 87 million, Great Britain 81 million, France 62 million, and Spain 57 million. Growth is strong throughout Asia and in South America but especially so in developing countries where landline systems were never fully established.

The investment firm Bank of America Merril-Lynch estimated that the worldwide penetration of mobile phone customers is twice that of landline customers today and that America has the highest minutes of use per month per user.[3] Today, 94% of Americans live in counties with four or more wireless service providers, plus 99% of Americans live in counties where next generation, 3G (third generation), 4G (fourth generation), and broadband services are available. All of this capacity requires an extensive infrastructure that the industry continues to build in the U.S., despite a 93% wireless penetration of the total U.S. population.[4]

Next generation services are continuing to drive the buildout of both new infrastructure as well as adaptation of preexisting sites. According to the industry, there are an estimated 251 618 cell sites in the U.S. today, up from 19 844 in 1995.[4] There is no comprehensive data for antennas hidden inside of buildings but one industry-maintained Web site (www.antennasearch.com), allows people to type in an address and all antennas within a 3 mile (1 mile = 1.6 km) area will come up. There are hundreds of thousands in the U.S. alone.

People are increasingly abandoning landline systems in favor of wireless communications. One estimate in 2006 found that 42% of all wireless subscribers used their wireless phone as their primary phone. According to the National Center for Health Statistics of the U.S. Centers for Disease Control (CDC), by the second half of 2008, one in every five American households had no landlines but did have at least one wireless phone (Department of Health and Human Services 2008). The figures reflected a 2.7% increase over the first half of 2008 — the largest jump since the CDC began tracking such data in 2003, and represented a total of 20.2% of the U.S. population — a figure that coincides with industry estimates of 24.50% of completely wireless households in 2010.[5] The CDC also found that approximately 18.7% of all children, nearly 14 million, lived in households with only wireless phones. The CDC further found that one in every seven American homes, 14.5% of the population, received all or almost all of their calls via wireless phones, even when there was a landline in the home. They called these "wireless-mostly households."

The trend away from landline phones is obviously increasing as wireless providers market their services specifically toward a mobile customer, particularly younger adults who readily embrace new technologies. One study (Silke et al. 2010) in Germany found that children from lower socioeconomic backgrounds not only owned more cell phones than children from higher economic groups, but also used their cell phones more often — as determined by the test groups' wearing of personal dosimetry devices. This was the first study to track such data and it found an interesting contradiction to the assumption that higher socioeconomic groups were the largest users of cell services. At one time, cell phones were the status symbol of the wealthy. Today, it is also a status symbol of lower socioeconomic groups. The CDC found in their survey discussed above that 65.3% of adults living in poverty or living near poverty were more likely than higher income adults to be living in households with wireless only telephones. There may be multiple reasons for these findings, including a shift away from cell phone dialogues to texting in younger adults in higher socioeconomic categories.

In some developing countries where landline systems have never been fully developed outside of urban centers, cell phones are the only means of communication. Cellular technology, especially the new 3G, 4G, and broadband services that allow wireless communications for real-time voice communication, text messaging, photos, Internet connections, music and video downloads, and TV viewing, is the fastest growing segment of many economies that are in otherwise sharp decline due to the global economic downturn.

There is some indication that although the cellular phone markets for many European countries are more mature than in the U.S., people there may be maintaining their landline use while augmenting with mobile phone capability. This may be a consequence of the more robust media coverage regarding health and safety issues of wireless technology in the European press, particularly in the UK, as well as recommendations by European governments like France and Germany[6] that citizens not abandon their landline phones or wired computer systems because of safety concerns. According to OfCom's 2008 *Communications Market Interim Report* (OfCom 2008), which provided information up to December 2007, approximately 86% of UK adults use cell phones. While four out of five households have both cell phones and landlines, only 11% use cell phones exclusively, a total down from 28% noted by this group in 2005. In addition, 44% of UK adults use text messaging on a daily basis. Fixed landline services fell by 9% in 2007 but OfCom notes that landline services continue to be strong despite the fact that mobile services also continued to grow by 16%. This indicates that people are continuing to use both landlines and wireless technology rather than choosing one over the other in the UK. There were 51 300 UK base station sites in

[2] http://www.eito.com/pressinformation_20100811.htm. (Accessed October 2010.)
[3] http://www.ctia.org/advocacy/research/index.cfm/AID/10377. (Accessed October 2010.)
[4] http://www.ctia.org/advocacy/research/index.cfm/AID/10323. (Accessed October 2010.)
[5] http://www.ctia.org/advocacy/research/index.cfm/AID/10323. (Accessed October 2010.)
[6] http://www.icems.eu/docs/deutscher_bundestag.pdf and http://www.icems.eu/docs/resolutions/EP_EMF_resolution_2APR09.pdf. (Accessed October 2010.)

the beginning of 2009 (two-thirds installed on existing buildings or structures) with an estimated 52 900 needed to accommodate new 3G and 4G services by the end of 2009.

Clearly, this is an enormous global industry. Yet, no money has ever been appropriated by the industry in the U.S., or by any U.S. government agency, to study the potential health effects on people living near the infrastructure. The most recent research has all come from outside of the U.S. According to the CTIA – The Wireless Association, "If the wireless telecom industry were a country, its economy would be bigger than that of Egypt, and, if measured by GNP (gross national product), [it] would rank as the 46th largest country in the world." They further say, "It took more than 21 years for color televisions to reach 100 million consumers, more than 90 years for landline service to reach 100 million consumers, and less than 17 years for wireless to reach 100 million consumers."[7]

In lieu of building new cell towers, some municipalities are licensing public utility poles throughout urban areas for Wi-Fi antennas that allow wireless Internet access. These systems can require hundreds of antennas in close proximity to the population with some exposures at a lateral height where second- and third-storey windows face antennas. Most of these systems are categorically excluded from regulation by the U.S. Federal Communications Commission (FCC) or oversight by government agencies because they operate below a certain power density threshold. However, power density is not the only factor determining biological effects from radiofrequency radiation (RFR).

In addition, when the U.S. and other countries permanently changed from analog signals used for television transmission to newer digital formats, the old analog frequencies were reallocated for use by municipal services such as police, fire, and emergency medical dispatch, as well as to private telecommunications companies wanting to expand their networks and services. This creates another significant increase in ambient background exposures.

Wi-Max is another wireless service in the wings that will broaden wireless capabilities further and place additional towers and (or) transmitters in close proximity to the population in addition to what is already in existence. Wi-Max aims to make wireless Internet access universal without tying the user to a specific location or "hotspot." The rollout of Wi-Max in the U.S., which began in 2009, uses lower frequencies at high power densities than currently used by cellular phone transmission. Many in science and the activist communities are worried, especially those concerned about electromagnetic-hypersensitivity syndrome (EHS).

It remains to be seen what additional exposures "smart grid" or "smart meter" technology proposals to upgrade the electrical powerline transmission systems will entail regarding total ambient RFR increases, but it will add another ubiquitous low-level layer. Some of the largest corporations on earth, notably Siemens and General Electric, are involved. Smart grids are being built out in some areas of the U.S. and in Canada and throughout Europe. That technology plans to alter certain aspects of powerline utility metering from a wired system to a partially wireless one. The systems require a combination of wireless transmitters attached to homes and businesses that will send radio signals of approximately 1 W output in the 2.4000–2.4835 GHz range to local "access point" transceivers, which will then relay the signal to a further distant information center (Tell 2008). Access point antennas will require additional power density and will be capable of interfacing with frequencies between 900 MHz and 1.9 GHz. Most signals will be intermittent, operating between 2 to 33 seconds per hour. Access points will be mounted on utility poles as well as on free-standing towers. The systems will form wide area networks (WANs), capable of covering whole towns and counties through a combination of "mesh-like" networks from house to house. Some meters installed on private homes will also act as transmission relays, boosting signals from more distant buildings in a neighborhood. Eventually, WANs will be completely linked.

Smart grid technology also proposes to allow homeowners to attach additional RFR devices to existing indoor appliances, to track power use, with the intention of reducing usage during peak hours. Manufacturers like General Electric are already making appliances with transmitters embedded in them. Many new appliances will be incapable of having transmitters deactivated without disabling the appliance and the warranty. People will be able to access their home appliances remotely by cell phone. The WANs smart grids described earlier in the text differ significantly from the current upgrades that many utility companies have initiated within recent years that already use low-power RFR meters attached to homes and businesses. Those first generation RFR meters transmit to a mobile van that travels through an area and "collects" the information on a regular billing cycle. Smart grids do away with the van and the meter reader and work off of a centralized RFR antenna system capable of blanketing whole regions with RFR.

Another new technology in the wings is broadband over powerlines (BPL). It was approved by the U.S. FCC in 2007 and some systems have already been built out. Critics of the latter technology warned during the approval process that radiofrequency interference could occur in homes and businesses and those warnings have proven accurate. BPL technology couples radiofrequency bands with extremely low frequency (ELF) bands that travel over powerline infrastructure, thereby creating a multi-frequency field designed to extend some distance from the lines themselves. Such couplings follow the path of conductive material, including secondary distribution lines, into people's homes.

There is no doubt that wireless technologies are popular with consumers and businesses alike, but all of this requires an extensive infrastructure to function. Infrastructure typically consists of freestanding towers (either preexisting towers to which cell antennas can be mounted, or new towers specifically built for cellular service), and myriad methods of placing transceiving antennas near the service being called for by users. This includes attaching antenna panels to the sides of buildings as well as roof-mountings; antennas hidden inside church steeples, barn silos, elevator shafts, and any number of other "stealth sites." It also includes camouflaging towers to look like trees indigenous to areas where they are placed, e.g., pine trees in northern climates, cacti

[7] CTIA website: http://www.ctia.org/advocay/research/index.cfm/AID/10385. (Accessed 9 December 2008.)

in deserts, and palm trees in temperate zones, or as chimneys, flagpoles, silos, or other tall structures (Rinebold 2001). Often the rationale for stealth antenna placement or camouflaging of towers is based on the aesthetic concerns of host communities.

An aesthetic emphasis is often the only perceived control of a municipality, particularly in countries like America where there is an overriding federal preemption that precludes taking the "environmental effects" of RFR into consideration in cell tower siting as stipulated in Section 704 of *The Telecommunications Act of 1996* (USFCC 1996). Citizen resistance, however, is most often based on health concerns regarding the safety of RFR exposures to those who live near the infrastructure. Many citizens, especially those who claim to be hypersensitive to electromagnetic fields, state they would rather know where the antennas are and that hiding them greatly complicates society's ability to monitor for safety.[8]

Industry representatives try to reassure communities that facilities are many orders of magnitude below what is allowed for exposure by standards-setting boards and studies bear that out (Cooper et al. 2006; Henderson and Bangay 2006; Bornkessel et al. 2007). These include standards by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) used throughout Europe, Canada, and elsewhere (ICNIRP 1998). The standards currently adopted by the U.S. FCC, which uses a two-tiered system of recommendations put out by the National Council on Radiation Protection (NCRP) for civilian exposures (referred to as uncontrolled environments), and the International Electricians and Electronics Engineers (IEEE) for professional exposures (referred to as controlled environments) (U.S. FCC 1997). The U.S. may eventually adopt standards closer to ICNIRP. The current U.S. standards are more protective than ICNIRP's in some frequency ranges so any harmonization toward the ICNIRP standards will make the U.S. limits more lenient.

All of the standards currently in place are based on RFRs ability to heat tissue, called thermal effects. A longstanding criticism, going back to the 1950s (Levitt 1995), is that such acute heating effects do not take potentially more subtle non-thermal effects into consideration. And based on the number of citizens who have tried to stop cell towers from being installed in their neighborhoods, laypeople in many countries do not find adherence to exisitng standards valid in addressing health concerns. Therefore, infrastructure siting does not have the confidence of the public (Levitt 1998).

2. A changing industry

Cellular phone technology has changed significantly over the last two decades. The first wireless systems began in the mid-1980s and used analog signals in the 850–900 MHz range. Because those wavelengths were longer, infrastructure was needed on average every 8 to 10 miles apart. Then came the digital personal communications systems (PCS) in the late 1990s, which used higher frequencies, around 1900 GHz, and digitized signals. The PCS systems, using shorter wavelengths and with more stringent exposure guidelines, require infrastructure approximately every 1 to 3 miles apart. Digital signals work on a binary method, mimicking a wave that allows any frequency to be split in several ways, thereby carrying more information far beyond just voice messages.

Today's 3G network can send photos and download music and video directly onto a cell phone screen or iPod. The new 4G systems digitize and recycle some of the older frequencies in the 700 to 875 MHz bands to create another service for wireless Internet access. The 4G network does not require a customer who wants to log on wirelessly to locate a "hot spot" as is the case with private Wi-Fi systems. Today's Wi-Fi uses a network of small antennas, creating coverage of a small area of 100 ft ($\sim$30 m) or so at homes or businesses. Wi-fi can also create a small wireless computer system in a school where they are often called wireless local area networks (WLANs). Whole cities can make Wi-Fi available by mounting antennas to utility poles.

Large-scale Wi-Fi systems have come under increasing opposition from citizens concerned about health issues who have legally blocked such installations (Antenna Free Union[9]). Small-scale Wi-Fi has also come under more scrutiny as governments in France and throughout Europe have banned such installations in libraries and schools, based on precautionary principles (REFLEX Program 2004).

3. Cell towers in perspective: some definitions

Cell towers are considered low-power installations when compared to many other commercial uses of radiofrequency energy. Wireless transmission for radio, television (TV), satellite communications, police and military radar, federal homeland security systems, emergency response networks, and many other applications all emit RFR, sometimes at millions of watts of effective radiated power (ERP). Cellular facilities, by contrast, use a few hundred watts of ERP per channel, depending on the use being called for at any given time and the number of service providers co-located at any given tower.

No matter what the use, once emitted, RFR travels through space at the speed of light and oscillates during propagation. The number of times the wave oscillates in one second determines its frequency.

Radiofrequency radiation covers a large segment of the electromagnetic spectrum and falls within the nonionizing bands. Its frequency ranges between 10 kHz to 300 GHz; 1 Hz = 1 oscillation per second; 1 kHz = 1000 Hz; 1 MHz = 1 000 000 Hz; and 1 GHz = 1 000 000 000 Hz.

Different frequencies of RFR are used in different applications. Some examples include the frequency range of 540 to 1600 kHz used in AM radio transmission; and 76 to 108 MHz used for FM radio. Cell-phone technology uses frequencies between 800 MHz and 3 GHz. The RFR of 2450 MHz is used in some Wi-Fi applications and microwave cooking.

Any signal can be digitized. All of the new telecommunications technologies are digitized and in the U.S., all TV is

[8] See, for example, www.radiationresearch.org. (Accessed October 2010.)
[9] http://www.antennafreeunion.org/. (Accessed October 2010.)

broadcast in 100% digital formats — digital television (DTV) and high definition television (HDTV). The old analog TV signals, primarily in the 700 MHz ranges, will now be recycled and relicensed for other applications to additional users, creating additional layers of ambient exposures.

The intensity of RFR is generally measured and noted in scientific literature in watts per square meter (W/m^2); milliwatts per square centimetre (mW/cm^2), or microwatts per square centimetre (μW/cm^2). All are energy relationships that exist in space. However, biological effects depend on how much of the energy is absorbed in the body of a living organism, not just what exists in space.

4. Specific absorption rate (SAR)

Absorption of RFR depends on many factors including the transmission frequency and the power density, one's distance from the radiating source, and one's orientation toward the radiation of the system. Other factors include the size, shape, mineral and water content of an organism. Children absorb energy differently than adults because of differences in their anatomies and tissue composition. Children are not just "little adults". For this reason, and because their bodies are still developing, children may be more susceptible to damage from cell phone radiation. For instance, radiation from a cell phone penetrates deeper into the head of children (Gandhi et al. 1996; Wiart et al. 2008) and certain tissues of a child's head, e.g., the bone marrow and the eye, absorb significantly more energy than those in an adult head (Christ et al. 2010). The same can be presumed for proximity to towers, even though exposure will be lower from towers under most circumstances than from cell phones. This is because of the distance from the source. The transmitter is placed directly against the head during cell phone use whereas proximity to a cell tower will be an ambient exposure at a distance.

There is little difference between cell phones and the domestic cordless phones used today. Both use similar frequencies and involve a transmitter placed against the head. But the newer digitally enhanced cordless technology (DECT) cordless domestic phones transmit a constant signal even when the phone is not in use, unlike the older domestic cordless phones. But some DECT brands are available that stop transmission if the mobile units are placed in their docking station.

The term used to describe the absorption of RFR in the body is specific absorption rate (SAR), which is the rate of energy that is actually absorbed by a unit of tissue. Specific absorption rates (SARs) are generally expressed in watts per kilogram (W/kg) of tissue. The SAR measurements are averaged either over the whole body, or over a small volume of tissue, typically between 1 and 10 g of tissue. The SAR is used to quantify energy absorption to fields typically between 100 kHz and 10 GHz and encompasses RFR from devices such as cellular phones up through diagnostic MRI (magnetic resonance imaging).

Specific absorption rates are a more reliable determinant and index of RFR's biological effects than are power density, or the intensity of the field in space, because SARs reflect what is actually being absorbed rather than the energy in space. However, while SARs may be a more precise model, at least in theory, there were only a handful of animal studies that were used to determine the threshold values of SAR for the setting of human exposure guidelines (de Lorge and Ezell 1980; de Lorge 1984). (For further information see Section 8). Those values are still reflected in today's standards.

It is presumed that by controlling the field strength from the transmitting source that SARs will automatically be controlled too, but this may not be true in all cases, especially with far-field exposures such as near cell or broadcast towers. Actual measurement of SARs is very difficult in real life so measurements of electric and magnetic fields are used as surrogates because they are easier to assess. In fact, it is impossible to conduct SAR measurements in living organisms so all values are inferred from dead animal measurements (thermography, calorimetry, etc.), phantom models, or computer simulation (FDTD).

However, according to the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) *Health Effects of Exposure to EMF*, released in January of 2009:

> ... recent studies of whole body plane wave exposure of both adult and children phantoms demonstrated that when children and small persons are exposed to levels which are in compliance with reference levels, exceeding the basic restrictions cannot be excluded [Dimbylow and Bloch 2007; Wang et al. 2006; Kuhn et al., 2007; Hadjem et al., 2007]. While the whole frequency range has been investigated, such effects were found in the frequency bands around 100 MHz and also around 2 GHz. For a model of a 5-year-old child it has been shown that when the phantom is exposed to electromagnetic fields at reference levels, the basic restrictions were exceeded by 40% [Conil et al., 2008].... Moreover, a few studies demonstrated that multipath exposure can lead to higher exposure levels compared to plane wave exposure [Neubauer et al. 2006; Vermeeren et al. 2007]. It is important to realize that this issue refers to far field exposure only, for which the actual exposure levels are orders of magnitude below existing guidelines. (p. 34–35, SCENIHR 2009)

In addition to average SARs, there are indications that biological effects may also depend on how energy is actually deposited in the body. Different propagation characteristics such as modulation, or different wave-forms and shapes, may have different effects on living systems. For example, the same amount of energy can be delivered to tissue continuously or in short pulses. Different biological effects may result depending on the type and duration of the exposure.

5. Transmission facilities

The intensity of RFR decreases rapidly with the distance from the emitting source; therefore, exposure to RFR from transmission towers is often of low intensity depending on one's proximity. But intensity is not the only factor. Living near a facility will involve long-duration exposures, sometimes for years, at many hours per day. People working at home or the infirm can experience low-level 24 h exposures. Nighttimes alone will create 8 h continuous exposures. The current standards for both ICNIRP, IEEE and the NCRP (adopted by the U.S. FCC) are for whole-body exposures averaged over a short duration (minutes) and are based on results from short-term exposure studies, not for long-term, low-level exposures such as those experienced by people living or working near transmitting facilities. For such populations, these can be involuntary exposures, unlike cell phones where user choice is involved.

There have been some recent attempts to quantify human SARs in proximity to cell towers but these are primarily for occupational exposures in close proximity to the sources and questions raised were dosimetry-based regarding the accuracy of antenna modeling (van Wyk et al. 2005). In one study by Martínez-Búrdalo et al. (2005) however, the researchers used high-resolution human body models placed at different distances to assess SARs in worst-case exposures to three different frequencies — 900, 1800, and 2170 MHz. Their focus was to compute whole-body averaged SARs at a maximum 10 g averaged SAR inside the exposed model. They concluded that for

> … antenna–body distances in the near zone of the antenna, the fact that averaged field values are below reference levels, could, at certain frequencies, not guarantee guidelines compliance based on basic restrictions.
> (p. 4125, Martínez-Búrdalo et al. 2005)

This raises questions about the basic validity of predicting SARs in real-life exposure situations or compliance to guidelines according to standard modeling methods, at least when one is very close to an antenna.

Thus, the relevant questions for the general population living or working near transmitting facilities are: Do biological and (or) health effects occur after exposure to low-intensity RFR? Do effects accumulate over time, since the exposure is of a long duration and may be intermittent? What precisely is the definition of low-intensity RFR? What might its biological effects be and what does the science tell us about such exposures?

6. Government radiofrequency radiation (RFR) guidelines: how spatial energy translates to the body's absorption

The U.S. FCC has issued guidelines for both power density and SARs. For power density, the U.S. guidelines are between 0.2–1.0 mW/cm^2. For cell phones, SAR levels require hand-held devices to be at or below 1.6 W/kg measured over 1.0 g of tissue. For whole body exposures, the limit is 0.08 W/kg.

In most European countries, the SAR limit for hand-held devices is 2.0 W/kg averaged over 10 g of tissue. Whole body exposure limits are 0.08 W/kg.

At 100–200 ft (~30–60 m) from a cell phone base station, a person can be exposed to a power density of 0.001 mW/cm^2 (i.e., 1.0 μW/cm^2). The SAR at such a distance can be 0.001 W/kg (i.e., 1.0 mW/kg). The U.S. guidelines for SARs are between 0.08–0.40 W/kg.

For the purposes of this paper, we will define low-intensity exposure to RFR of power density of 0.001 mW/cm^2 or a SAR of 0.001 W/kg.

7. Biological effects at low intensities

Many biological effects have been documented at very low intensities comparable to what the population experiences within 200 to 500 ft (~60–150 m) of a cell tower, including effects that occurred in studies of cell cultures and animals after exposures to low-intensity RFR. Effects reported include: genetic, growth, and reproductive; increases in permeability of the blood–brain barrier; behavioral; molecular, cellular, and metabolic; and increases in cancer risk. Some examples are as follows:

- Dutta et al. (1989) reported an increase in calcium efflux in human neuroblastoma cells after exposure to RFR at 0.005 W/kg. Calcium is an important component in normal cellular functions.
- Fesenko et al. (1999) reported a change in immunological functions in mice after exposure to RFR at a power density of 0.001 mW/cm^2.
- Magras and Xenos (1997) reported a decrease in reproductive function in mice exposed to RFR at power densities of 0.000168–0.001053 mW/cm^2.
- Forgacs et al. (2006) reported an increase in serum testosterone levels in rats exposed to GSM (global system for mobile communication)-like RFR at SAR of 0.018–0.025 W/kg.
- Persson et al. (1997) reported an increase in the permeability of the blood–brain barrier in mice exposed to RFR at 0.0004–0.008 W/kg. The blood–brain barrier is a physiological mechanism that protects the brain from toxic substances, bacteria, and viruses.
- Phillips et al. (1998) reported DNA damage in cells exposed to RFR at SAR of 0.0024–0.024 W/kg.
- Kesari and Behari (2009) also reported an increase in DNA strand breaks in brain cells of rats after exposure to RFR at SAR of 0.0008 W/kg.
- Belyaev et al. (2009) reported changes in DNA repair mechanisms after RFR exposure at a SAR of 0.0037 W/kg. A list of publications reporting biological and (or) health effects of low-intensity RFR exposure is in Table 1.

Out of the 56 papers in the list, 37 provided the SAR of exposure. The average SAR of these studies at which biological effects occurred is 0.022 W/kg — a finding below the current standards.

Ten years ago, there were only about a dozen studies reporting such low-intensity effects; currently, there are more than 60. This body of work cannot be ignored. These are important findings with implications for anyone living or working near a transmitting facility. However, again, most of the studies in the list are on short-term (minutes to hours) exposure to low-intensity RFR. Long-term exposure studies are sparse. In addition, we do not know if all of these reported effects occur in humans exposed to low-intensity RFR, or whether the reported effects are health hazards. Biological effects do not automatically mean adverse health effects, plus many biological effects are reversible. However, it is clear that low-intensity RFR is not biologically inert. Clearly, more needs to be learned before a presumption of safety can continue to be made regarding placement of antenna arrays near the population, as is the case today.

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Table 1. List of studies reporting biological effects at low intensities of radiofrequency radiation (RFR).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density (μW/cm^2)	Effects reported
Balmori (2010) (in vivo) (eggs and tadpoles of frog)	88.5–1873.6 MHz	Cell phone base station emission	2 months		3.25	Retarded development
Belyaev et al. (2005) (in vitro)	915 MHz	GSM	24, 48 h	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz	GSM, UMTS	24, 72 h	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz	AM at 16 Hz		0.0014		Calcium in forebrain of chickens
Boscol et al. (2001) (in vivo) (human whole body)	500 KHz–3 GHz	TV broadcast			0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz	CW (CW– no effect observed) AM at 50 Hz	14 days, 5, 10, 20 min per day		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz	GSM	1 h/day, 3 days	0.07		A slight decrease in cell proliferation when human immune cells were stimulated with mitogen and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane
Chiang et al. (1989) (in vivo) (human whole body)	Lived and worked close to AM radio and radar installations for more than 1 year				10	People lived and worked near AM radio antennas and radar installations showed deficits in psychological and short-term memory tests
de Pomerai et al. (2003) (in vitro)	1 GHz		24, 48 h	0.015		Protein damages
D'Inzeo et al. (1988) (in vitro)	10.75 GHz	CW	30–120 s	0.008		Operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions
Dutta et al. (1984) (in vitro)	915 MHz	Sinusoidal AM at 16 Hz	30 min	0.05		Increase in calcium efflux in brain cancer cells
Dutta et al. (1989) (in vitro)	147 MHz	Sinusoidal AM at 16 Hz	30 min	0.005		Increase in calcium efflux in brain cancer cells
Fesenko et al. (1999) (in vivo) (mouse- wavelength in mm range)	From 8.15–18 GHz		5 h to 7 days direction of response depended on exposure duration		1	Change in immunological functions
Forgacs et al. (2006) (in vivo) (mouse whole body)	1800 MHz	GSM, 217 Hz pulses, 576 μs pulse width	2 h/day, 10 days	0.018		Increase in serum testosterone
Guler et al. (2010) (In vivo) (rabbit whole body)	1800 MHz	AM at 217 Hz	15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars				10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references
Ivaschuk et al. (1997) (in vitro)	836.55 MHz	TDMA	20 min	0.026		A gene related to cancer
Jech et al. (2001) (in vivo) (human partial body exposure-narcoleptic patients)	900 MHz	GSM— 217 Hz pulses, 577 μs pulse width	45 min	0.06		Improved cognitive functions
Kesari and Behari (2009) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2010) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz	50 Hz modulation	2 h/day, 35 days	0.11		DNA double strand breaks in brain cells
Kwee et al. (2001) (in vitro)	960 MHz	GSM	20 min	0.0021		Increased stress protein in human epithelial amnion cells
Lebedeva et al. (2000) (in vivo) (human partial body)	902.4 MHz	GSM	20 min		60	Brain wave activation
Lerchl et al. (2008) (in vivo) (hamster whole body)	383 MHz 900 and 1800 MHz	TETRA GSM	24 h/day, 60 days	0.08		Metabolic changes
Magras and Xenos (1997) (in vivo) (mouse whole body)	"Antenna park"	TV and FM-radio	Exposure over several generations		0.168	Decrease in reproductive function
Mann et al. (1998) (in vivo) (human whole body)	900 MHz	GSM pulse-modulated at 217 Hz, 577 μs width	8 h		20	A transient increase in blood cortisol
Marinelli et al. (2004) (in vitro)	900 MHz	CW	2–48 h	0.0035		Cell's self-defense responses triggered by DNA damage
Markovà et al. (2005) (in vitro)	915 and 905 MHz	GSM	1 h	0.037		Chromatin conformation in human white blood cells
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz 3000 MHz	CW (no effect observed) Pulse-modulated 2 μs pulses at 400 Hz	Single (0.5–12hr) or repeated (15–60 days, 7–12 h/day) exposure, CW–no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin
Nittby et al. (2008) (in vivo) (rat whole body)	900 MHz,	GSM	2 h/week, 55 weeks	0.0006		Reduced memory functions
Novoselova et al. (1999) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time – 16 ms reverse, 5 h		1	Functions of the immune system
Novoselova et al. (2004) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time16 ms reverse, 1.5 h/day, 30 days		1	Decreased tumor growth rate and enhanced survival

Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Panagopoulos et al. (2010) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		1–10	Reproductive capacity and induced cell death
Panagopoulos and Margaritis (2010*a*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		10	'Window' effect of GSM radiation on reproductive capacity and cell death
Panagopoulos and Margaritis (2010*b*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	1–21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure
Pavicic and Trosic (2008) (in vitro)	864 and 935 MHz	CW	1–3 h	0.08		Growth affected in Chinese hamster V79 cells
Pérez-Castejón et al. (2009) (in vitro)	9.6 GHz	90% AM	24 h	0.0004		Increased proliferation rate in human astrocytoma cancer cells
Persson et al. (1997) (in vivo) (mouse whole body)	915 MHz	CW and pulse-modulated (217 Hz, 0.57 ms; 50 Hz, 6.6 ms)	2–960 min; CW more potent	0.0004		Increase in permeability of the blood–brain barrier
Phillips et al. (1998) (in vitro)	813.5625 MHz 836.55 MHz	iDEN TDMA	2, 21 h 2, 21 h	0.0024		DNA damage in human leukemia cells
Pologea-Moraru et al. (2002) (in vitro)	2.45 GHz		1 h		15	Change in membrane of cells in the retina
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz	GSM (50 Hz pulses, 20 μs pulse length)	1–7 days postcoitum	0.0005		Exposure during early gestation affected kidney development
Roux et al. (2008*a*) (in vivo) (tomato whole body)	900 MHz				7	Gene expression and energy metabolism
Roux et al. (2008*b*) (in vivo) (plant whole body)	900 MHz				7	Energy metabolism
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz	GSM	2 h	0.02		Nerve cell damage in brain
Sarimov et al. (2004) (in vitro)	895–915 MHz	GSM	30 min	0.0054		Human lymphocyte chromatin affected similar to stress response
Schwartz et al. (1990) (in vitro)	240 MHz	CW and sinusoidal modulation at 0.5 and 16 Hz, effect only observed at 16 Hz modulation	30 min	0.00015		Calcium movement in the heart
Schwarz et al. (2008) (in vitro)	1950 MHz	UMTS	24 h	0.05		Genes in human fibroblasts
Somosy et al. (1991) (in vitro)	2.45 GHz	CW and 16 Hz square-modulation, modulated field more potent than CW		0.024		Molecular and structural changes in cells of mouse embryos

Table 1 (*concluded*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density (μW/cm^2)	Effects reported
Stagg et al. (1997) (in vitro)	836.55 MHz	TDMA duty cycle 33%	24 h	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division
Stankiewicz et al. (2006) (in vitro)	900 MHz	GSM 217 Hz pulses, 577 ms width		0.024		Immune activities of human white blood cells
Tattersall et al. (2001) (in vitro)	700 MHz	CW	5–15 min	0.0016		Function of the hippocampus
Velizarov et al. (1999) (in vitro)	960 MHz	GSM 217 Hz square-pulse, duty cycle 12%	30 min	0.000021		Decrease in proliferation of human epithelial amnion cells
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz	1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM, direction of response depended on AM frequency		0.015		Functions of the immune system
Vian et al. (2006) (in vivo) plant	900 MHz				7	Stress gene expression
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz 900 MHz	Square-wave modulated at 217 Hz CW, 16 Hz, 50 Hz, and 30 KHz modulations		0.001		Calcium concentration in heart muscle cells of guinea pig
Yurekli et al. (2006) (in vivo) (rat whole body)	945 MHz	GSM, 217 Hz pulse-modulation	7 h/day, 8 days	0.0113		Free radical chemistry

Note: These papers gave either specific absorption rate, SAR, (W/kg) or power density (μW/cm^2) of exposure. (Studies that did not contain these values were excluded). AM, amplitude-modulated or amplitude-modulation; CW, continuous wave; GSM, global system for mobile communication; iDEN, integrated digital enhanced network; TDMA, time division multiple access, TETRA, terrestrial trunked radio; UMTS, universal mobile telecommunications system.

8. Long-term exposures and cumulative effects

There are many important gaps in the RFR research. The majority of the studies on RFR have been conducted with short-term exposures, i.e., a few minutes to several hours. Little is known about the effects of long-term exposure such as would be experienced by people living near telecommunications installations, especially with exposures spanning months or years. The important questions then are: What are the effects of long-term exposure? Does long-term exposure produce different effects from short-term exposure? Do effects accumulate over time?

There is some evidence of cumulative effects. Phillips et al. (1998) reported DNA damage in cells after 24 h exposure to low-intensity RFR. DNA damage can lead to gene mutation that accumulates over time. Magras and Xenos (1997) reported that mice exposed to low-intensity RFR became less reproductive. After five generations of exposure the mice were not able to produce offspring. This shows that the effects of RFR can pass from one generation to another. Persson et al. (1997) reported an increase in permeability of the blood–brain barrier in mice when the energy deposited in the body exceeded 1.5 J/kg (joule per kilogram) — a measurement of the total amount of energy deposited. This suggests that a short-term, high-intensity exposure can produce the same effect as a long-term, low-intensity exposure, and is another indication that RFR effects can accumulate over time.

In addition, there is some indication that test animals become more sensitive to radiation after long-term exposure as seen in two of the critical experiments that contributed to the present SAR standards, called the "behavior–disruption experiments" carried out in the 1980s.

In the first experiment, de Lorge and Ezell (1980) trained rats on an auditory observing-response task. In the task, an animal was presented with two bars. Pressing the right bar would produce either a low-pitch or a high-pitch tone for half a second. The low-pitch tone signaled an unrewarded situation and the animal was expected to do nothing. However, when the high-pitch tone was on, pressing the left bar would produce a food reward. Thus, the task required continuous vigilance in which an animal had to coordinate its motor responses according to the stimulus presented to get a reward by choosing between a high-pitch or low-pitch tone. After learning the task, rats were then irradiated with 1280 MHz or 5620 MHz RFR during performance. Disruption of behavior (i.e., the rats could not perform very well) was observed within 30–60 min of exposure at a SAR of 3.75 W/kg for 1280 MHz, and 4.9 W/kg for 5620 MHz.

In another experiment, de Lorge (1984) trained monkeys on a similar auditory observing response task. Monkeys were exposed to RFR at 225, 1300, and 5800 MHz. Disruption of performance was observed at 8.1 mW/cm^2 (SAR 3.2 W/kg) for 225 MHz; at 57 mW/cm^2 (SAR 7.4 W/kg) for 1300 MHz; and at 140 mW/cm^2 (SAR 4.3 W/kg) for 5800 MHz. The disruption occurred when body temperature was increased by 1°C.

The conclusion from these experiments was that "... disruption of behavior occurred when an animal was exposed at an SAR of approximately 4 W/kg, and disruption occurred after 30–60 minutes of exposure and when body temperature increased by 1°C" (de Lorge 1984). Based on just these two experiments, 4 W/kg has been used in the setting of the present RFR exposure guidelines for humans. With theoretical safety margins added, the limit for occupational exposure was then set at 0.4 W/kg (i.e., 1/10 of the SAR where effects were observed) and for public exposure 0.08 W/kg for whole body exposures (i.e., 1/5 of that of occupational exposure).

But the relevant question for establishing a human SAR remains: Is this standard adequate, based on so little data, primarily extrapolated from a handful of animal studies from the same investigators? The de Lorge (1984) animal studies noted previously describe effects of short-term exposures, defined as less than one hour. But are they comparable to long-term exposures like what whole populations experience when living or working near transmitting facilities?

Two series of experiments were conducted in 1986 on the effects of long-term exposure. D'Andrea et al. (1986*a*) exposed rats to 2450 MHz RFR for 7 h a day, 7 days per week for 14 weeks. They reported a disruption of behavior at an SAR of 0.7 W/kg. And D'Andrea et al. (1986*b*) also exposed rats to 2450 MHz RFR for 7 h a day, 7 days per week, for 90 days at an SAR of 0.14 W/kg and found a small but significant disruption in behavior. The experimenters concluded, "... the threshold for behavioral and physiological effects of chronic (long-term) RFR exposure in the rat occurs between 0.5 mW/cm^2 (0.14 W/kg) and 2.5 mW/cm^2 (0.7 W/kg)" (p. 55, D'Andrea et al. 1986*b*).

The previously mentioned studies show that RFR can produce effects at much lower intensities after test animals are repeatedly exposed. This may have implications for people exposed to RFR from transmission towers for long periods of time.

Other biological outcomes have also been reported after long-term exposure to RFR. Effects were observed by Baranski (1972) and Takashima et al. (1979) after prolonged, repeated exposure but not after short-term exposure. Conversely, in other work by Johnson et al. (1983), and Lai et al. (1987, 1992) effects that were observed after short-term exposure disappeared after prolonged, repeated exposure, i.e., habituation occurred. Different effects were observed by Dumansky and Shandala (1974) and Lai et al. (1989) after different exposure durations. The conclusion from this body of work is that effects of long-term exposure can be quite different from those of short-term exposure.

Since most studies with RFR are short-term exposure studies, it is not valid to use their results to set guidelines for long-term exposures, such as in populations living or working near cell phone base stations.

9. Effects below 4 W/kg: thermal versus nonthermal

As described previously, current international RFR exposure standards are based mainly on the acute exposure experiments that showed disruption of behavior at 4 W/kg. However, such a basis is not scientifically valid. There are many studies that show biological effects at SARs less than 4 W/kg after short-term exposures to RFR. For example, since the 4 W/kg originated from psychological and (or) behavioral experiments, when one surveys the EMF literature on behavioral effects, one can find many reports on behavioral effects observed at SARs less than 4 W/kg, e.g., D'Andrea et al. (1986*a*) at 0.14 to 0.7 W/kg; DeWitt et al. (1987) at 0.14 W/kg; Gage (1979) at 3 W/kg ; King et al. (1971) at 2.4 W/kg; Kumlin et al. (2007) at 3 W/kg; Lai et al. (1989) at 0.6 W/kg; Mitchell et al. (1977) at 2.3 W/kg (1977); Navakatikian and Tomashevskaya (1994) at 0.027 W/kg; Nittby et al. (2008) at 0.06 W/kg; Schrot et al. (1980) at 0.7 W/kg; Thomas et al. (1975) at 1.5 to 2.7 W/kg; and Wang and Lai (2000) at 1.2 W/kg.

The obvious mechanism of effects of RFR is thermal (i.e., tissue heating). However, for decades, there have been questions about whether nonthermal (i.e., not dependent on a change in temperature) effects exist. This is a well-discussed area in the scientific literature and not the focus of this paper but we would like to mention it briefly because it has implications for public safety near transmission facilities.

Practically, we do not actually need to know whether RFR effects are thermal or nonthermal to set exposure guidelines. Most of the biological-effects studies of RFR that have been conducted since the 1980s were under nonthermal conditions. In studies using isolated cells, the ambient temperature during exposure was generally well controlled. In most animal studies, the RFR intensity used usually did not cause a significant increase in body temperature in the test animals. Most scientists consider nonthermal effects as established, even though the implications are not fully understood.

Scientifically, there are three rationales for the existence of nonthermal effects:

1. Effects can occur at low intensities when a significant increase in temperature is not likely.
2. Heating does not produce the same effects as RFR exposure.
3. RFR with different modulations and characteristics produce different effects even though they may produce the same pattern of SAR distribution and tissue heating.

Low-intensityeffects have been discussed previously (see Section 7.). There are reports that RFR triggers effects that are different from an increase in temperature, e.g., Wachtel et al. (1975); Seaman and Wachtel (1978); D'Inzeo et al. (1988). And studies showing that RFR of the same frequency and intensity, but with different modulations and waveforms, can produce different effects as seen in the work of Baranski (1972); Arber and Lin (1985); Campisi et al. (2010); d'Ambrosio et al. (2002); Frey et al. (1975); Oscar and Hawkins (1977); Sanders et al. (1985); Huber et al. (2002); Markkanen et al. (2004); Hung et al. (2007); and Luukkonen et al. (2009).

A counter-argument for point 1 is that RFR can cause micro-heating at a small location even though there is no measurement change in temperature over the whole sample. This implies that an effect observed at low intensities could be due to localized micro-heating, and, therefore, is still considered thermal. However, the micro-heating theory could not apply to test subjects that are not stationary, such as in the case of Magras and Xenos (1997) who reported that mice exposed to low-intensity RFR became less reproductive over several generations. "Hot spots" of heating move within the body when the subject moves in the field and, thus, cannot maintain sustained heating of certain tissue.

The counter argument for point 2 is that heating by other means does not produce the same pattern of energy distribution as RFR. Thus, different effects would result. Again, this counter argument does not work on moving objects. Thus, results supporting the third point are the most compelling.

10. Studies on exposure to cell tower transmissions

From the early genesis of cell phone technology in the early 1980s, cell towers were presumed safe when located near populated areas because they are low-power installations in comparison with broadcast towers. This thinking already depended on the assumption that broadcast towers were safe if kept below certain limits. Therefore, the reasoning went, cell towers would be safer still. The thinking also assumed that exposures between cell and broadcast towers were comparable. In certain cities, cell and broadcast tower transmissions both contributed significantly to the ambient levels of RFR (Sirav and Seyhan 2009; Joseph et al. 2010).

There are several fallacies in this thinking, including the fact that broadcast exposures have been found unsafe even at regulated thresholds. Adverse effects have been noted for significant increases for all cancers in both men and women living near broadcast towers (Henderson and Anderson 1986); childhood leukemia clusters (Maskarinec et al. 1994; Ha et al. 2003; Park et al. 2004); adult leukemia and lymphoma clusters, and elevated rates of mental illness (Hocking et al. 1996; Michelozzi et al. 2002; Ha et al. 2007); elevated brain tumor incidence (Dolk et al. 1997*a*, 1997*b*); sleep disorders, decreased concentration, anxiety, elevated blood pressure, headaches, memory impairment, increased white cell counts, and decreased lung function in children (Altpeter et al. 2000); motor, memory, and learning impairment in children (Kolodynski and Kolodynski 1996), nonlinear increases in brain tumor incidence (Colorado Department of Public Health 2004); increases in malignant melanoma (Hallberg and Johansson 2002); and nonlinear immune system changes in women (Boscol et al. 2001). (The term "nonlinear" is used in scientific literature to mean that an effect was not directly proportional to the intensity of exposure. In the case of the two studies mentioned previously, adverse effects were found at significant distances from the towers, not in closer proximity where the power density exposures were higher and therefore presumed to have a greater chance of causing effects. This is something that often comes up in low-level energy studies and adds credence to the argument that low-level exposures could cause qualitatively different effects than higher level exposures.)

There is also anecdotal evidence in Europe that some communities have experienced adverse physical reactions after the switch from analog TV broadcast signals to the new digital formats, which can be more biologically complex

Three doctors in Germany, Cornelia Waldmann-Selsam, MD, Christine Aschermann, MD, and Markus Kern, MD, wrote (in a letter to the U.S. President, entitled *Warning — Adverse Health Effects From Digital Broadcast Television*)[10], that on 20 May 2006, two digital broadcast television stations went on the air in the Hessian Rhoen area. Prior to that time that area had low radiation levels, which included that from cell phone towers of which there were few. However, coinciding with the introduction of the digital signals, within a radius of more than 20 km, there was an abrupt onset of symptoms for constant headaches, pressure in the head, drowsiness, sleep problems, inability to think clearly, forgetfulness, nervousness, irritability, tightness in the chest, rapid heartbeat, shortness of breath, depression, apathy, loss of empathy, burning skin, sense of inner burning, leg weakness, pain in the limbs, stabbing pain in various organs, and weight gain. They also noted that birds fled the area. The same symptoms gradually appeared in other locations after digital signals were introduced. Some physicians accompanied affected people to areas where there was no TV reception from terrestrial sources, such as in valleys or behind mountain ranges, and observed that many people became symptom free after only a short time. The digital systems also require more transmitters than the older analog systems and, therefore, somewhat higher exposure levels to the general population are expected, according to the 2009 SCENIHR Report (SCENIHR 2009).

Whether digital or analog, the frequencies differ between broadcast and cell antennas and do not couple with the human anatomy in whole-body or organ-specific models in the same ways (NCRP 1986; ICNIRP 1998). This difference in how the body absorbs energy is the reason that all standards-setting organizations have the strictest limitations between 30–300 MHz — ranges that encompass FM broadcast where whole body resonance occurs (Cleveland 2001). Exposure allowances are more lenient for cell technology in frequency ranges between 300 MHz and 3 GHz, which encompass cellular phone technology. This is based on the assumption that the cell frequencies do not penetrate the body as deeply and no whole-body resonance can occur.

There are some studies on the health effects on people living near cell phone towers. Though cell technology has been in existence since the late 1980s, the first study of populations near cell tower base stations was only conducted by Santini et al. (2002). It was prompted in part by complaints of adverse effects experienced by residents living near cell base stations throughout the world and increased activism by citizens. As well, increasing concerns by physicians to understand those complaints was reflected in professional organizations like the ICEMS (International Committee on Electromagnetic Safety) Catania Resolution[11], the Irish Doctors Environmental Association (IDEA)[12], and the Freiburger Appeal[13].

Santini conducted a survey study of 530 people (270 men, 260 women) on 18 nonspecific health symptoms (NSHS) in relation to self-reported distance from towers of <10 m, 10 to 50 m, 50 to 100 m, 100 to 200 m, 200 to 300 m, and >300 m. The control group compared people living more than 300 m (approximately 1000 ft) or not exposed to base stations. They controlled for age, presence of electrical transformers (<10 m), high tension lines (<100 m), and radio/TV broadcast transmitters (<4 km), the frequency of cell phone use (>20 min per day), and computer use (>2 h per day). Questions also included residents' location in relation to antennas, taking into account orientations that were facing, beside, behind, or beneath antennas in cases of roof-mounted antenna arrays. Exposure conditions were defined by the length of time living in the neighborhood (<1 year through >5 years); the number of days per week and hours per day (<1 h to >16 h) that were spent in the residence.

Results indicated increased symptoms and complaints the closer a person lived to a tower. At <10 m, symptoms included nausea, loss of appetite, visual disruptions, and difficulty in moving. Significant differences were observed up through 100 m for irritability, depressive tendencies, concentration difficulties, memory loss, dizziness, and lower libido. Between 100 and 200 m, symptoms included headaches, sleep disruption, feelings of discomfort, and skin problems. Beyond 200 m, fatigue was significantly reported more often than in controls. Women significantly reported symptoms more often than men, except for libido loss. There was no increase in premature menopause in women in relation to distance from towers. The authors concluded that there were different sex-dependent sensitivities to electromagnetic fields. They also called for infrastructure not to be sited <300 m (~1000 ft) from populations for precautionary purposes, and noted that the information their survey captured might not apply to all circumstances since actual exposures depend on the volume of calls being generated from any particular tower, as well as on how radiowaves are reflected by environmental factors.

Similar results were found in Egypt by Abdel-Rassoul et al. (2007) looking to identify neurobehavioral deficits in people living near cell phone base stations. Researchers conducted a cross-sectional study of 85 subjects: 37 living inside a building where antennas were mounted on the rooftop and 48 agricultural directorate employees who worked in a building ($\sim$10 m) opposite the station. A control group of 80 who did not live near base stations were matched for age, sex, occupation, smoking, cell phone use, and educational level. All participants completed a questionnaire containing personal, educational, and medical histories; general and neurological examinations; a neurobehavioral test battery (NBTB) involving tests for visuomotor speed, problem solving, attention, and memory, in addition to a Eysenck personality questionnaire (EPQ).

Their results found a prevalence of neuropsychiatric complaints: headaches, memory changes, dizziness, tremors, depressive symptoms, and sleep disturbance were significantly higher among exposed inhabitants than controls. The NBTB indicated that the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory (paced auditory

[10] http://www.notanotherconspiracy.com/2009/02/warning-adverse-health-effects-from.html. (Accessed October 2010.)
[11] http://www.icems.eu/resolution.htm
[12] http://www.ideeaireland.org/emr.htm
[13] http://www.laleva.cc/environment/freiburger_appeal.html

serial addition test (PASAT)). Also, the inhabitants opposite the station exhibited a lower performance in the problem-solving test (block design) than those who lived under the station. All inhabitants exhibited a better performance in the two tests of visuomotor speed (digit symbol and Trailmaking B) and one test of attention (Trailmaking A) than controls.

Environmental power-density data were taken from measurements of that building done by the National Telecommunications Institute in 2000. Measurements were collected from the rooftop where the antennas were positioned, the shelter that enclosed the electrical equipment and cables for the antennas, other sites on the roof, and within an apartment below one of the antennas. Power-density measurements ranged from 0.1–6.7 μW/cm². No measurements were taken in the building across the street. The researchers noted that the last available measurements of RFR in 2002 in that area were less than the allowable standards but also noted that exposures depended on the number of calls being made at any given time, and that the number of cell phone users had increased approximately four times within the 2 years just before the beginning of their study in 2003. They concluded that inhabitants living near mobile phone base stations are at risk for developing neuropsychiatric problems, as well as some changes in the performance of neurobehavioral functions, either by facilitation (over-stimulation) or inhibition (suppression). They recommended the standards be revised for public exposure to RFR, and called for using the NBTB for regular assessment and early detection of biological effects among inhabitants near base stations (Abdel-Rassoul et al. 2007).

Hutter et al. (2006) sought to determine cognitive changes, sleep quality, and overall well-being in 365 rural and urban inhabitants who had lived for more than a year near 10 selected cell phone base stations. Distance from antennas was 24 to 600 m in rural areas, and 20 to 250 m in the urban areas. Field strength measurements were taken in bedrooms and cognitive tests were performed. Exposure to high-frequency EMFs was lower than guidelines and ranged from 0.000002 to 0.14 μW/cm² for all frequencies between 80 MHz and 2 GHz with the greater exposure coming from mobile telecommunications facilities, which was between 0.000001 and 0.14 μW/cm². Maximum levels were between 0.000002 and 0.41 μW/cm² with an overall 5% of the estimated maximum above 0.1 μW/cm². Average levels were slightly higher in rural areas (0.005 μW/cm²) than in urban areas (0.002 μW/cm²). The researchers tried to ascertain if the subjective rating of negative health consequences from base stations acted as a covariable but found that most subjects expressed no strong concerns about adverse effects from the stations, with 65% and 61% in urban and rural areas, respectively, stating no concerns at all. But symptoms were generally higher for subjects who expressed health concerns regarding the towers. The researchers speculated that this was due to the subjects with health complaints seeking answers and consequently blaming the base station; or that subjects with concerns were more anxious in general and tended to give more negative appraisals of their body functions; and the fact that some people simply give very negative answers.

Hutter's results were similar to those of Santini et al. (2002) and Abdel-Rassoul et al. (2007). Hutter found a significant relationship between symptoms and power densities. Adverse effects were highest for headaches, cold hands and feet, cardiovascular symptoms, and concentration difficulties. Perceptual speed increased while accuracy decreased insignificantly with increasing exposure levels. Unlike the others, however, Hutter found no significant effects on sleep quality and attributed such problems more to fear of adverse effects than actual exposure. They concluded that effects on well-being and performance cannot be ruled out even as mechanisms of action remain unknown. They further recommended that antenna siting should be done to minimize exposure to the population.

Navarro et al. (2003) measured the broadband electric field (E-field) in the bedrooms of 97 participants in La Nora, Murcia, Spain and found a significantly higher symptom score in 9 out of 16 symptoms in the groups with an exposure of 0.65 V/m (0.1121 μW/cm²) compared with the control group with an exposure below 0.2 V/m (0.01061 μW/cm²), both as an average. The highest contributor to the exposure was GSM 900/1800 MHz signals from mobile telecommunications. The same researchers also reported significant correlation coefficients between the measured E-field and 14 out of 16 health-related symptoms with the five highest associations found for depressive tendencies, fatigue, sleeping disorders, concentration difficulties, and cardiovascular problems. In a follow up work, Oberfeld et al. (2004) conducted a health survey in Spain in the vicinity of two GSM 900/1800 MHz cell phone base stations, measuring the E-field in six bedrooms, and found similar results. They concluded that the symptoms are in line with "microwave syndrome" reported in the literature (Johnson-Liakouris 1998). They recommended that the sum total for ambient exposures should not be higher than 0.02 V/m — the equivalent of a power density of 0.00011 μW/cm², which is the indoor exposure value for GSM base stations proposed by the Public Health Office of the Government of Salzburg, Austria in 2002[14].

Eger et al. (2004) took up a challenge to medical professionals by Germany's radiation protection board to determine if there was an increased cancer incidence in populations living near cell towers. Their study evaluated data for approximately 1000 patients between the years of 1994 and 2004 who lived close to cell antennas. The results showed that the incidence of cancer was significantly higher among those patients who had lived for 5 to 10 years at a distance of up to 400 m from a cell installation that had been in operation since 1993, compared with those patients living further away, and that the patients fell ill on an average of 8 years earlier than would be expected. In the years between 1999 and 2004, after 5 years operation of the transmitting installation, the relative risk of getting cancer had tripled for residents in proximity of the installation compared with inhabitants outside of the area.

Wolf and Wolf (2004) investigated increased cancer incidence in populations living in a small area in Israel exposed

[14] http://www.salzburg.gv.at/umweltmedizin. (Accessed October 2010.)

to RFR from a cell tower. The antennas were mounted 10 m high, transmitting at 850 MHz and 1500 W at full-power output. People lived within a 350 m half circle of the antennas. An epidemiologic assessment was done to determine whether the incidence of cancer cases among individuals exposed to the base station in the south section of the city of Netanya called Irus (designated area A) differed from expected cancer rates throughout Israel, and in the town of Netanya in general, as compared with people who lived in a nearby area without a cell tower (designated area B). There were 622 participants in area A who had lived near the cell tower for 3 to 7 years and were patients at one health clinic. The exposure began 1 year before the start of the study when the station first came into service. A second cohort of individuals in area B, with 1222 participants who received medical services at a different clinic located nearby, was used as a control. Area B was closely matched for environment, workplace, and occupational characteristics. In exposure area A, eight cases of different types of cancer were diagnosed in a period of 1 year, including cancers of the ovary (1), breast (3), Hodgkins lymphoma (1), lung (1), osteoid osteoma (1), and hypernephroma (1). The RFR field measurements were also taken per house and matched to the cancer incidents. The rate of cancers in area A was compared with the annual rate of the general population (31 cases per 10 000) and to incidence for the entire town of Netanya. There were two cancers in area B, compared to eight in area A. They also examined the history of the exposed cohort (area A) for malignancies in the 5 years before exposure began and found only two cases in comparison to eight cases 1 year after the tower went into service. The researchers concluded that relative cancer rates for females were 10.5 for area A, 0.6 for area B, and 1.0 for the whole town of Netanya. Cancer incidence in women in area A was thus significantly higher ($p < 0.0001$) compared with that of area B and the whole city. A comparison of the relative risk revealed that there were 4.15 times more cases in area A than in the entire population. The study indicated an association between increased incidence of cancer and living in proximity to a cell phone base station. The measured level of RFR, between 0.3 to 0.5 $\mu W/cm^2$, was far below the thermal guidelines.

11. Risk perception, electrohypersensitivity, and psychological factors

Others have followed up on what role risk perception might play in populations near cell base stations to see if it is associated with health complaints.

Blettner et al. (2008) conducted a cross-sectional, multiphase study in Germany. In the initial phase, 30 047 people out of a total of 51 444, who took part in a nationwide survey, were also asked about their health and attitudes towards mobile phone base stations. A list of 38 potential health complaints were used. With a response rate of 58.6%, 18.0% were concerned about adverse health effects from base stations, 10.3% directly attributed personal adverse effects to them. It was found that people living within 500 m, or those concerned about personal exposures, reported more health complaints than others. The authors concluded that even though a substantial proportion of the German population is concerned about such exposures, the observed higher health complaints cannot be attributed to those concerns alone.

Kristiansen et al. (2009) also explored the prevalence and nature of concerns about mobile phone radiation, especially since the introduction of new 3G–UMTS (universal mobile telecommunications system) networks that require many more towers and antennas have sparked debate throughout Europe. Some local governments have prohibited mobile antennas on public buildings due to concerns about cancer, especially brain cancer in children and impaired psychomotor functions. One aim of the researchers was risk assessment — to compare people's perceptions of risk from cell phones and masts to other fears, such as being struck by lightening. In Denmark, they used data from a 2006 telephone survey of 1004 people aged 15+ years. They found that 28% of the respondents were concerned about exposure to mobile phone radiation and 15% about radiation from masts. In contrast, 82% of respondents were concerned about other forms of environmental pollution. Nearly half of the respondents considered the mortality risk of 3G phones and masts to be of the same order of magnitude as being struck by lightning (0.1 fatalities per million people per year), while 7% thought it was equivalent to tobacco-induced lung cancer (approximately 500 fatalities per million per year). Among women, concerns about mobile phone radiation, perceived mobile phone mortality risk, and concerns about unknown consequences of new technologies, increased with educational levels. More than two thirds of the respondents felt that they had not received adequate public information about the 3G system. The results of the study indicated that the majority of the survey population had little concern about mobile phone radiation, while a minority is very concerned.

Augner et al. (2009) examined the effects of short-term GSM base station exposure on psychological symptoms including good mood, alertness, and calmness as measured by a standardized well-being questionnaire. Fifty-seven participants were randomly assigned to one of three different exposure scenarios. Each of those scenarios subjected participants to five 50 min exposure sessions, with only the first four relevant for the study of psychological symptoms. Three exposure levels were created by shielding devices, which could be installed or removed between sessions to create double-blinded conditions. The overall median power densities were 0.00052 $\mu W/cm^2$ during low exposures, 0.0154 $\mu W/cm^2$ during medium exposures, and 0.2127 $\mu W/cm^2$ during high-exposure sessions. Participants in high- and medium-exposure scenarios were significantly calmer during those sessions than participants in low-exposure scenarios throughout. However, no significant differences between exposure scenarios in the "good mood" or "alertness" factors were found. The researchers concluded that short-term exposure to GSM base station signals may have an impact on well-being by reducing psychological arousal.

Eltiti et al. (2007) looked into exposures to the GSM and UMTS exposures from base stations and the effects to 56 participants who were self-reported as sensitive to electromagnetic fields. Some call it electro-hypersensitivity (EHS) or just electrosensitivity. People with EHS report that they suffer negative health effects when exposed to electromagnetic fields from everyday objects such as cell phones, mobile phone base stations, and many other common things in modern societies. EHS is a recognized functional impairment in Sweden. This study used both open provocation and double-blind tests to determine if electrosensitive and control individuals experienced more negative health effects when exposed to base-station-like signals compared with sham exposures. Fifty-six electrosensitive and 120 control participants were tested first in an open provocation test. Of these, 12 electrosensitive and six controls withdrew after the first session. Some of the electrosensitive subjects later issued a statement saying that the initial exposures made them too uncomfortable to continue participating in the study. This means that the study may have lost its most vulnerable test subjects right at the beginning, possibly skewing later outcomes. The remainder completed a series of double-blind tests. Subjective measures of well-being and symptoms, as well as physiological measures of blood-volume pulse, heart rate, and skin conductance were obtained. They found that during the open provocation, electrosensitive individuals reported lower levels of well-being to both GSM and UMTS signals compared with sham exposure, whereas controls reported more symptoms during the UMTS exposure. During double-blind tests the GSM signal did not have any effect on either group. Electrosensitive participants did report elevated levels of arousal during the UMTS condition, but the number or severity of symptoms experienced did not increase. Physiological measures did not differ across the three exposure conditions for either group. The researchers concluded that short-term exposure to a typical GSM base-station-like signal did not affect well-being or physiological functions in electrosensitive or control individuals even though the electrosensitive individuals reported elevated levels of arousal when exposed to a UMTS signal. The researchers stated that this difference was likely due to the effect of the order of the exposures throughout the series rather than to the exposure itself. The researchers do not speculate about possible data bias when one quarter of the most sensitive test subjects dropped out at the beginning.

In follow-up work, Eltiti et al. (2009) attempted to clarify some of the inconsistencies in the research with people who report sensitivity to electromagnetic fields. Such individuals, they noted, often report cognitive impairments that they believe are due to exposure to mobile phone technology. They further said that previous research in this area has revealed mixed results, with the majority of research only testing control individuals. Their aim was to clarify whether short-term (50 min) exposure at 1 $\mu W/cm^2$ to typical GSM and UMTS base station signals affects attention, memory, and physiological endpoints in electrosensitive and control participants. Data from 44 electrosensitive and 44 matched-control participants who performed the digit symbol substitution task (DSST), digit span task (DS), and a mental arithmetic task (MA), while being exposed to GSM, UMTS, and sham signals under double-blind conditions were analyzed. Overall, the researchers concluded that cognitive functioning was not affected by short-term exposure to either GSM or UMTS signals. Nor did exposure affect the physiological measurements of blood-volume pulse, heart rate, and skin conductance that were taken while participants performed the cognitive tasks. The GSM signal was a combined signal of 900 and 1800 MHz frequencies, each with a power flux density of 0.5 $\mu W/cm^2$, which resulted in combined power flux density of 1 $\mu W/cm^2$ over the area where test subjects were seated. Previous measurements in 2002 by the National Radiological Protection Board in the UK, measuring power density from base stations at 17 sites and 118 locations (Mann et al. 2002), found that in general, the power flux density was between 0.001 $\mu W/cm^2$ to 0.1 $\mu W/cm^2$, with the highest power density being 0.83 $\mu W/cm^2$. The higher exposure used by the researchers in this study was deemed comparable by them to the maximum exposure a person would encounter in the real world. But many electrosensitive individuals report that they react to much lower exposures too. Overall, the electrosensitive participants had a significantly higher level of mean skin conductance than control subjects while performing cognitive tasks. The researchers noted that this was consistent with other studies that hypothesize sensitive individuals may have a general imbalance in autonomic nervous system regulation. Generally, cognitive functioning was not affected in either electrosensitives or controls. When Bonferroni corrections were applied to the data, the effects on mean skin conductance disappeared. A criticism is that this averaging of test results hides more subtle effects.

Wallace et al. (2010) also tried to determine if short-term exposure to RFR had an impact on well-being and what role, if any, psychological factors play. Their study focused on "Airwave", a new communication system being rolled out across the UK for police and emergency services. Some police officers have complained about skin rashes, nausea, headaches, and depression as a consequence of using Airwave two-way radio handsets. The researchers used a small group of self-reported electrosensitive people to determine if they reacted to the exposures, and to determine if exposures to specific signals affect a selection of the adult population who do not report sensitivity to electromagnetic fields. A randomized double-blind provocation study was conducted to establish whether short-term exposure to a terrestrial trunked radio (TETRA) base station signal has an impact on health and well-being in individuals with electrosensitivity and controls. Fifty-one individuals with electrosensitivity and 132 age- and gender-matched controls participated first in an open provocation test, while 48 electrosensitive and 132 control participants went on to complete double-blind tests in a fully screened semi-anechoic chamber. Heart rate, skin conductance, and blood pressure readings provided objective indices of short-term physiological response. Visual analogue scales and symptom scales provided subjective indices of well-being. Their results found no differences on any measure between TETRA and sham (no signal) under double-blind conditions for either control or electrosensitive participants and neither group could detect the presence of a TETRA signal above chance (50%). The researchers noted, however, that when conditions were not double-blinded, the electrosensitive individuals did report feeling worse and experienced more severe symptoms during TETRA compared with sham exposure. They concluded that the adverse symptoms experienced by electrosensitive individuals are caused by the belief of harm from TETRA base stations rather than because of the low-level EMF exposure itself.

It is interesting to note that the three previously mentioned studies were all conducted at the same Electromagnetics and Health Laboratory at the University of Essex, Essex, UK, by the same relative group of investigators. Those claiming to be electrosensitive are a small subgroup in the population, often in touch through Internet support groups. In the first test, many electrosensitives dropped out because they found the exposures used in the study too uncomfortable. The drop-out rate decreased with the subsequent studies, which raises the question of whether the electrosensitive participants in the latter studies were truly electrosensitive. There is a possibility that a true subgroup of electrosensitives cannot tolerate such study conditions, or that potential test subjects are networking in a way that preclude their participation in the first place. In fact, researchers were not able to recruit their target numbers for electrosensitive participants in any of the studies. The researchers also do not state if there were any of the same electrosensitive participants used in the three studies. Nor do they offer comment regarding the order of the test methods possibly skewing results.

Because of uncertainty regarding whether EMF exposures are actually causing the symptoms that electrosensitives report, and since many electrosensitives also report sensitivities to myriad chemicals and other environmental factors, it has been recommended (Hansson Mild et al. 2006) that a new term be used to describe such individuals — idiopathic environmental intolerance with attribution to electromagnetic fields (IEI-EMF).

Furubayashi et al. (2009) also tried to determine if people who reported symptoms to mobile phones are more susceptible than control subjects to the effect of EMF emitted from base stations. They conducted a double-blind, cross-over provocation study, sent questionnaires to 5000 women and obtained 2472 valid responses from possible candidates. From those, they were only able to recruit 11 subjects with mobile phone related symptoms (MPRS) and 43 controls. The assumption was that individuals with MPRS matched the description of electrosensitivity by the World Health Organization (WHO). There were four EMF exposure conditions, each of which lasted 30 min: (*i*) continuous, (*ii*) intermittent, (*iii*) sham exposure with noise, and (*iv*) sham exposure without noise. Subjects were exposed to EMF of 2.14 GHz, 10 V/m (26.53 μW/cm^2) wideband code division multiple access (W-CDMA), in a shielded room to simulate whole-body exposure to EMF from base stations, although the exposure strength they used was higher than that commonly received from base stations. The researchers measured several psychological and cognitive parameters immediately before and after exposure, and monitored autonomic functions. Subjects were asked to report on their perception of EMF and level of discomfort during the experiment. The MPRS group did not differ from the controls in their ability to detect exposure to EMF. They did, however, consistently experience more discomfort in general, regardless of whether or not they were actually exposed to EMF, and despite the lack of significant changes in their autonomic functions. The researchers noted that others had found electrosensitive subjects to be more susceptible to stress imposed by task performance, although they did not differ from normal controls in their personality traits. The researchers concluded that the two groups did not differ in their responses to real or sham EMF exposure according to any psychological, cognitive or autonomic assessment. They said they found no evidence of any causal link between hypersensitivity symptoms and exposure to EMF from base stations. However, this study, had few MPRS participants.

Regel et al. (2006) also investigated the effects of the influence of UMTS base-station-like signals on well-being and cognitive performance in subjects with and without self-reported sensitivity to RFR. The researchers performed a controlled exposure experiment in a randomized, double-blind crossover study, with 45 min at an electric field strength of 0 V/m, 1.0 V/m (0.2653 μW/cm^2), or 10.0 V/m (26.53 μW/cm^2), incident with a polarization of 45° from the left-rear side of the subject, at weekly intervals. A total of 117 healthy subjects that included 33 self-reported sensitive subjects and 84 nonsensitive subjects, participated in the study. The team assessed well-being, perceived field strength, and cognitive performance with questionnaires and cognitive tasks and conducted statistical analyses using linear mixed models. Organ-specific and brain-tissue-specific dosimetry, including uncertainty and variation analysis, was performed. Their results found that in both groups, well-being and perceived field strength were not associated with actual exposure levels. They observed no consistent condition-induced changes in cognitive performance except for two marginal effects. At 10 V/m (26.53 μW/cm^2) they observed a slight effect on speed in one of six tasks in the sensitive subjects and an effect on accuracy in another task in nonsensitive subjects. Both effects disappeared after multiple endpoint adjustments. They concluded that they could not confirm a short-term effect of UMTS base-station-like exposure on well-being. The reported effects on brain functioning were marginal, which they attributed to chance. Peak spatial absorption in brain tissue was considerably smaller than during use of a mobile phone. They concluded that no conclusions could be drawn regarding short-term effects of cell phone exposure or the effects of long-term base-station-like exposures on human health.

Siegrist et al. (2005) investigated risk perceptions associated with mobile phones, base stations, and other sources of EMFs through a telephone survey conducted in Switzerland. Participants assessed both risks and benefits associated with nine different sources of EMF. Trust in the authorities regulating these hazards was also assessed. Participants answered a set of questions related to attitudes toward EMF and toward mobile phone base stations. Their results were: high-voltage transmission lines are perceived as the most risky source of EMF; and mobile phones and base stations received lower risk ratings. Trust in authorities was positively associated with perceived benefits and negatively associated with perceived risks. Also, people who use their mobile phones frequently perceived lower risks and higher benefits than people who use their mobile phones infrequently. People who believed they lived close to a base station did not significantly differ in their perceived level of risks associated with mobile phone base stations from people who did not believe they lived close to a base station. A majority of participants favored limits to exposures based on worst-case scenarios. The researchers also correlated perceived risks with other beliefs and found that belief in paranormal phenomena is related to level of perceived risks associated with

EMF. In addition, people who believed that most chemical substances cause cancer also worried more about EMF than people who did not believe that chemical substances are harmful. This study found the obvious — that some people worry more about environmental factors than others across a range of concerns.

Wilen et al. (2006) investigated the effects of exposure to mobile phone RFR on people who experience subjective symptoms when using mobile phones. Twenty subjects with MPRS were matched with 20 controls without MPRS. Each subject participated in two experimental sessions, one with true exposure and one with sham exposure, in random order. In the true exposure condition, the test subjects were exposed for 30 min to an RFR field generating a maximum SAR (1 g) in the head of 1 W/kg through an indoor base station antenna attached to signals from a 900 MHz GSM mobile phone. Physiological and cognitive parameters were measured during the experiment for heart rate and heart rate variability (HRV), respiration, local blood flow, electrodermal activity, critical flicker fusion threshold (CFFT), short-term memory, and reaction time. No significant differences related to RFR exposure conditions and no differences in baseline data were found between subject groups with the exception for reaction time, which was significantly longer among the test subjects than among the controls the first time the test was performed. This difference disappeared when the test was repeated. However, the test subjects differed significantly from the controls with respect to HRV as measured in the frequency domain. The test subjects displayed a shift in the low/high frequency ratio towards a sympathetic dominance in the autonomous nervous system during the CFFT and memory tests, regardless of exposure condition. They interpreted this as a sign of differences in the autonomous nervous system regulation among persons with MPRS and persons with no such symptoms.

12. Assessing exposures

Quantifying, qualifying, and measuring radiofrequency (RF) energy both indoors and outdoors has frustrated scientists, researchers, regulators, and citizens alike. The questions involve how best to capture actual exposure data — through epidemiology, computer estimates, self-reporting, or actual dosimetry measurements. Determining how best to do this is more important than ever, given the increasing background levels of RFR. Distance from a generating source has traditionally been used as a surrogate for probable power density but that is imperfect at best, given how RF energy behaves once it is transmitted. Complicated factors and numerous variables come into play. The wearing of personal dosimetry devices appears to be a promising area for capturing cumulative exposure data.

Neubauer et al. (2007) asked the question if epidemiology studies are even possible now, given the increasing deployment of wireless technologies. They examined the methodological challenges and used experts in engineering, dosimetry, and epidemiology to critically evaluate dosimetric concepts and specific aspects of exposure assessment regarding epidemiological study outcomes. They concluded that, at least in theory, epidemiology studies near base stations are feasible but that all relevant RF sources have to be taken into account. They called for pilot studies to validate exposure assessments and recommended that short-to-medium term effects on health and well-being are best investigated by cohort studies. They also said that for long-term effects, groups with high exposures need to be identified first, and that for immediate effects, human laboratory studies are the preferred approach. In other words, multiple approaches are required. They did not make specific recommendations on how to quantify long-term, low-level effects on health and well-being.

Radon et al. (2006) compared personal RF dosimetry measurements against recall to ascertain the reliability of self-reporting near base stations. Their aim was to test the feasibility and reliability of personal dosimetry devices. They used a 24 h assessment on 42 children, 57 adolescents, and 64 adults who wore a Maschek dosimeter prototype, then compared the self-reported exposures with the measurements. They also compared the readings of Maschek prototype with those of the Antennessa DSP-090 in 40 test subjects. They found that self-reported exposures did not correlate with actual readings. The two dosimeters were in moderate agreement. Their conclusion was that personal dosimetry, or the wearing of measuring devices, was a feasible method in epidemiology studies.

A study by Frei et al. (2009) also used personal dosimetry devices to examine the total exposure levels of RFR in the Swiss urban population. What they found was startling — nearly a third of the test subjects' cumulative exposures were from cell base stations. Prior to this study, exposure from base stations was thought to be insignificant due to their low-power densities and to affect only those living or working in close proximity to the infrastructure. This study showed that the general population moves in and out of these particular fields with more regularity than previously expected. In a sample of 166 volunteers from Basel, Switzerland, who agreed to wear personal exposure meters (called exposimeters), the researchers found that nearly one third of total exposures came from base stations. Participants carried an exposimeter for 1 week (2 separate weeks in 32 participants) and also completed an activity diary. Mean values were calculated using the robust regression on order statistics (ROS) method. Results found a mean weekly exposure to all RFR and (or) EMF sources was 0.013 $\mu W/cm^2$ (range of individual means 0.0014–0.0881 $\mu W/cm^2$). Exposure was mainly from mobile phone base stations (32.0%), mobile phone handsets (29.1%), and digital enhanced cordless telecommunications (DECT) phones (22.7%). People owning a DECT phone (total mean 0.015 $\mu W/cm^2$) or mobile phone (0.014 $\mu W/cm^2$) were exposed more than those not owning a DECT or mobile phone (0.010 $\mu W/cm^2$). Mean values were highest in trains (0.116 $\mu W/cm^2$), airports (0.074 $\mu W/cm^2$), and tramways or buses (0.036 $\mu W/cm^2$) and were higher during daytime (0.016 $\mu W/cm^2$) than nighttime (0.008 $\mu W/cm^2$). The Spearman correlation coefficient between mean exposure in the first and second week was 0.61. Another surprising finding of this study contradicted Neubauer et al. (2008) who found that a rough dosimetric estimate of a 24 h exposure from a base station (1–2 V/m) (i.e., 0.2653–1.061 $\mu W/cm^2$) corresponded to approximately 30 min of mobile phone use. But Frei et al. (2009) found, using the exposimeter, that cell phone use was 200 times higher than the average base station exposure contribution in self-selected volunteers (0.487 versus 0.002 $\mu W/cm^2$). This implied that at the belt, backpack, or in close vicinity to the body, the mean base station contribution corresponds to about 7 min of mobile phone use (24 h divided by 200), not 30 min. They concluded that exposure to RFR varied considerably between persons and locations but was fairly consistent for individuals. They noted that cell phones, base stations, and cordless phones were important sources of exposure in urban Switzerland but that people could reduce their exposures by replacing their cordless domestic phones with conventional landlines at home. They determined that it was feasible to combine diary data with personal exposure measurements and that such data was useful in evaluating RFR exposure during daily living, as well as helpful in reducing exposure misclassification in future epidemiology studies.

Viel et al. (2009) also used personal exposure meters (EME SPY 120 made by Satimo and ESM 140 made by Maschek) to characterize actual residential exposure from antennas. Their primary aim was to assess personal exposures, not ambient field strengths. Two hundred randomly selected people were enrolled to wear measurement meters for 24 h and asked to keep a time–location–activity diary. Two exposure metrics for each radiofrequency were then calculated: the proportion of measurements above the detection limit of 0.05 V/m (0.0006631 $\mu W/cm^2$) and the maximum electric field strength. Residential addresses were geocoded and distances from each antenna were calculated. They found that much of the time-recorded field strength was below the detection level of 0.05 V/m, with the exception of the FM radio bands, which had a detection threshold of 12.3%. The maximum electric field was always lower than 1.5 V/m (0.5968 $\mu W/cm^2$). Exposure to GSM and digital cellular system (DCS) frequencies peaked around 280 m in urban areas and 1000 m from antennas in more suburban/rural areas. A downward trend in exposures was found within a 10 km distance for FM exposures. Conversely, UMTS, TV3, and TV 4 and 5 signals did not vary with distance. The difference in peak exposures for cell frequencies were attributed to microcell antennas being more numerous in urban areas, often mounted a few meters above ground level, whereas macrocell base stations in less urban areas are placed higher (between 15 and 50 m above ground level) to cover distances of several kilometres. They concluded that despite the limiting factors and high variability of RF exposure assessments, in using sound statistical technique they were able to determine that exposures from GSM and DCS cellular base stations actually increase with distance in the near source zone, with a maximum exposure where the main beam intersects the ground. They noted that such information should be available to local authorities and the public regarding the siting of base stations. Their findings coincide with Abdel-Rassoul et al. (2007) who found field strengths to be less in the building directly underneath antennas, with reported health complaints higher in inhabitants of the building across the street.

Amoako et al. (2009) conducted a survey of RFR at public access points close to schools, hospitals, and highly populated areas in Ghana near 50 cell phone base stations. Their primary objective was to measure and analyze field strength levels. Measurements were made using an Anritsu model MS 2601A spectrum analyzer to determine the electric field level in the 900 and 1800 MHz frequency bands. Using a GPS (global positioning system), various base stations were mapped. Measurements were taken at 1.5 m above ground to maintain line of sight with the RF source. Signals were measured during the day over a 3 h period, at a distance of approximately 300 m. The results indicated that power densities for 900 MHz at public access points varied from as low as 0.000001 $\mu W/cm^2$ to as high as 0.001 $\mu W/cm^2$. At 1800 MHz, the variation of power densities was from 0.000001 to 0.01 $\mu W/cm^2$. There are no specific RFR standards in Ghana. These researchers determined that while their results in most cites were compliant with the ICNIRP standards, levels were still 20 times higher than values typically found in the UK, Australia, and the U.S., especially for Ghana base stations in rural areas with higher power output. They determined that there is a need to reduce RFR levels since an increase in mobile phone usage is foreseen.

Clearly, predicting actual exposures based on simple distance from antennas using standardized computer formulas is inadequate. Although power density undoubtedly decreases with distance from a generating source, actual exposure metrics can be far more complex, especially in urban areas. Contributing to the complexity is the fact that the narrow vertical spread of the beam creates a low RF field strength at the ground directly below the antenna. As a person moves away or within a particular field, exposures can become complicated, creating peaks and valleys in field strength. Scattering and attenuation alter field strength in relation to building placement and architecture, and local perturbation factors can come into play. Power density levels can be 1 to 100 times lower inside a building, depending on construction materials, and exposures can differ greatly within a building, depending on numerous factors such as orientation toward the generating source and the presence of conductive materials. Exposures can be twice as high in upper floors than in lower floors, as found by Anglesio et al. (2001).

However, although distance from a transmitting source has been shown to be an unreliable determinant for accurate exposure predictions, it is nevertheless useful in some general ways. For instance, it has been shown that radiation levels from a tower with 15 nonbroadcast radio systems will fall off to hypothetical natural background levels at approximately 1500 ft ($\sim$500 m) (Rinebold 2001). This would be in general agreement with the lessening of symptoms in people living near cell towers at a distance over 1000 ft ($\sim$300 m) found by Santini et al. (2002) .

The previously mentioned studies indicate that accuracy in both test design and personal dosimetry measurements are possible in spite of the complexities and that a general safer distance from a cell tower for residences, schools, daycare centers, hospitals, and nursing homes might be ascertained.

13. Discussion

Numerous biological effects do occur after short-term exposures to low-intensity RFR but potential hazardous health effects from such exposures on humans are still not well established, despite increasing evidence as demonstrated throughout this paper. Unfortunately, not enough is known about biological effects from long-term exposures, especially as the effects of long-term exposure can be quite different from those of short-term exposure. It is the long-term, low-intensity exposures that are most common today and increasing significantly from myriad wireless products and services.

People are reporting symptoms near cell towers and in proximity to other RFR-generating sources including consumer products such as wireless computer routers and Wi-Fi systems that appear to be classic "microwave sickness syndrome," also known as "radiofrequency radiation sickness." First identified in the 1950s by Soviet medical researchers, symptoms included headache, fatigue, ocular dysfunction, dizziness, and sleep disorders. In Soviet medicine, clinical manifestations include dermographism, tumors, blood changes, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment, among others. The Soviet researchers noted that the syndrome is reversible in early stages but is considered lethal over time (Tolgskaya et al. 1973).

Johnson-Liakouris (1998) noted there are both occupational studies conducted between 1953 and 1991 and clinical cases of acute exposure between 1975 and 1993 that offer substantive verification for the syndrome. Yet, U.S. regulatory agencies and standards-setting groups continue to quibble about the existence of microwave sickness because it does not fit neatly into engineering models for power density, even as studies are finding that cell towers are creating the same health complaints in the population. It should be noted that before cellular telecommunications technology, no such infrastructure exposures between 800 MHz and 2 GHz existed this close to so many people. Microwave ovens are the primary consumer product utilizing a high RF intensity, but their use is for very brief periods of time and ovens are shielded to prevent leakage above 1000 $\mu W/cm^2$ — the current FDA standard. In some cases, following the U.S. Telecommunications Act of 1996 preemption of local health considerations in infrastructure siting, antennas have been mounted within mere feet of dwellings. And, on buildings with roof-mounted arrays, exposures can be lateral with top floors of adjacent buildings at close range.

It makes little sense to keep denying health symptoms that are being reported in good faith. Though the prevalence of such exposures is relatively new to a widespread population, we, nevertheless, have a 50 year observation period to draw from. The primary questions now involve specific exposure parameters, not the reality of the complaints or attempts to attribute such complaints to psychosomatic causes, malingering, or beliefs in paranormal phenomenon. That line of argument is insulting to regulators, citizens, and their physicians. Serious mitigation efforts are overdue.

There is early Russian and U.S. documentation of long-term, very low-level exposures causing microwave sickness as contained in *The Johns Hopkins Foreign Service Health Status Study* done in 1978 (Lilienfield et al. 1978; United States Senate 1979). This study contains both clinical information, and clear exposure parameters. Called the Lilienfield study, it was conducted between 1953 and 1976 to determine what, if any, effects there had been to personnel in the U.S. Embassy in Moscow after it was discovered that the Soviet government had been systematically irradiating the U.S. government compound there.

The symptoms reported were not due to any known tissue heating properties. The power densities were not only very low but the propagation characteristics were remarkably similar to what we have today with cell phone base stations. Lilienfield recorded exposures for continuous-wave, broadband, modulated RFR in the frequency ranges between 0.6 and 9.5 GHz. The exposures were long-term and low-level at 6 to 8 h per day, 5 days per week, with the average length of exposure time per individual between 2 to 4 years. Modulation information contained phase, amplitude, and pulse variations with modulated signals being transmitted for 48 h or less at a time. Radiofrequency power density was between 2 and 28 $\mu W/cm^2$ — levels comparable to recent studies cited in this paper.

The symptoms that Lilienfield found included four that fit the Soviet description for dermographism — eczema, psoriasis, allergic, and inflammatory reactions. Also found were neurological problems with diseases of peripheral nerves and ganglia in males; reproductive problems in females during pregnancy, childbearing, and the period immediately after delivery (puerperium); tumor increases (malignant in females, benign in males); hematological alterations; and effects on mood and well-being including irritability, depression, loss of appetite, concentration, and eye problems. This description of symptoms in the early literature is nearly identical to the Santini, Abdel-Rassoul, and Narvarro studies cited earlier, as well as the current (though still anecdotal) reports in communities where broadcast facilities have switched from analog to digital signals at power intensities that are remarkably similar. In addition, the symptoms in the older literature are also quite similar to complaints in people with EHS.

Such reports of adverse effects on well-being are occurring worldwide near cell infrastructure and this does not appear to be related to emotional perceptions of risk. Similar symptoms have also been recorded at varying distances from broadcast towers. It is clear that something else is going on in populations exposed to low-level RFR that computer-generated RFR propagation models and obsolete exposure standards, which only protect against acute exposures, do not encompass or understand. With the increase in so many RFR-emitting devices today, as well as the many in the wings that will dramatically increase total exposures to the population from infrastructure alone, it may be time to approach this from a completely different perspective.

It might be more realistic to consider ambient outdoor and indoor RFR exposures in the same way we consider other environmental hazards such as chemicals from building materials that cause sick building syndrome. In considering public health, we should concentrate on aggregate exposures from multiple sources, rather than continuing to focus on individual source points like cell and broadcast base stations. In addition, whole categorically excluded technologies must be included for systems like Wi-Fi, Wi-Max, smart grids, and smart metering as these can greatly increase ambient radiation levels. Only in that way will low-level electromagnetic energy exposures be understood as the broad environmental factor it is. Radiofrequency radiation is a form of energetic air pollution and it should be controlled as such. Our current predilection to take this one product or service at a time does not encompass what we already know beyond reasonable doubt. Only when aggregate exposures are better understood by consumers will disproportionate resistance to base station siting bring more intelligent debate into the public arena and help create safer infrastructure. That can also benefit the industries trying to satisfy customers who want such services.

Safety to populations living or working near communications infrastructure has not been given the kind of attention it deserves. Aggregate ambient outdoor and indoor exposures should be emphasized by summing up levels from different generating source points in the vicinity. Radiofrequency radiation should be treated and regulated like radon and toxic chemicals, as aggregate exposures, with appropriate recommendations made to the public including for consumer products that may produce significant RFR levels indoors. When indoor consumer products such as wireless routers, cordless/DECT phones, leaking microwave ovens, wireless speakers, and (or) security systems, etc. are factored in with nearby outdoor transmission infrastructure, indoor levels may rise to exposures that are unsafe. The contradictions in the studies should not be used to paralyze movement toward safer regulation of consumer products, new infrastructure creation, or better tower siting. Enough good science exists regarding long-term low-level exposures — the most prevalent today — to warrant caution.

The present U.S. guidelines for RFR exposure are not up to date. The most recent IEEE and NCRP guidelines used by the U.S. FCC have not taken many pertinent recent studies into consideration because, they argue, the results of many of those studies have not been replicated and thus are not valid for standards setting. That is a specious argument. It implies that someone tried to replicate certain works but failed to do so, indicating the studies in question are unreliable. However, in most cases, no one has tried to exactly replicate the works at all. It must be pointed out that the 4 W/kg SAR threshold based on the de Lorge studies have also not been replicated independently. In addition, effects of long-term exposure, modulation, and other propagation characteristics are not considered. Therefore, the current guidelines are questionable in protecting the public from possible harmful effects of RFR exposure and the U.S. FCC should take steps to update their regulations by taking all recent research into consideration without waiting for replication that may never come because of the scarcity of research funding. The ICNIRP standards are more lenient in key exposures to the population than current U.S. FCC regulations. The U.S. standards should not be "harmonized" toward more lenient allowances. The ICNIRP should become more protective instead. All standards should be biologically based, not dosimetry based as is the case today.

Exposure of the general population to RFR from wireless communication devices and transmission towers should be kept to a minimum and should follow the "As Low As Reasonably Achievable" (ALARA) principle. Some scientists, organizations, and local governments recommend very low exposure levels — so low, in fact, that many wireless industries claim they cannot function without many more antennas in a given area. However, a denser infrastructure may be impossible to attain because of citizen unwillingness to live in proximity to so many antennas. In general, the lowest regulatory standards currently in place aim to accomplish a maximum exposure of 0.02 V/m, equal to a power density of 0.0001 $\mu W/cm^2$, which is in line with Salzburg, Austria's indoor exposure value for GSM cell base stations. Other precautionary target levels aim for an outdoor cumulative exposure of 0.1 $\mu W/cm^2$ for pulsed RF exposures where they affect the general population and an indoor exposure as low as 0.01 $\mu W/cm^2$ (Sage and Carpenter 2009). In 2007, *The BioInitiative Report, A rationale for a biologically based public exposure standard for electromagnetic fields (ELF and RF)*, also made this recommendation, based on the precautionary principle (Bioinitiative Report 2007).

Citizens and municipalities often ask for firm setbacks from towers to guarantee safety. There are many variables involved with safer tower siting — such as how many providers are co-located, at what frequencies they operate, the tower's height, surrounding topographical characteristics, the presence of metal objects, and others. Hard and fast setbacks are difficult to recommend in all circumstances. Deployment of base stations should be kept as efficient as possible to avoid exposure of the public to unnecessary high levels of RFR. As a general guideline, cell base stations should not be located less than 1500 ft (~500 m) from the population, and at a height of about 150 ft (~50 m). Several of the papers previously cited indicate that symptoms lessen at that distance, despite the many variables involved. However, with new technologies now being added to cell towers such as Wi-Max networks, which add significantly more power density to the environment, setback recommendations can be a very unpredictable reassurance at best. New technology should be developed to reduce the energy required for effective wireless communication.

In addition, regular RFR monitoring of base stations should be considered. Some communities require that ambient background levels be measured at specific distances from proposed tower sites before, and after, towers go online to establish baseline data in case adverse effects in the population are later reported. The establishment of such baselines would help epidemiologists determine what changed in the environment at a specific point in time and help better assess if RFR played a role in health effects. Unfortunately, with so much background RFR today, it is almost impossible to find a clean RFR environment. Pretesting may have become impossible in many places. This will certainly be the case when smart grid technologies create a whole new blanket of low-level RFR, with millions of new transceivers attached to people's homes and appliances, working off of centralized RFR hubs in every neighborhood. That one technology alone has the ability to permanently negate certain baseline data points.

The increasing popularity of wireless technologies makes understanding actual environmental exposures more critical with each passing day. This also includes any potential effects on wildlife. There is a new environmental concept taking form — that of "air as habitat" (Manville 2007) for species such as birds, bats, and insects, in the same way that water is considered habitat for marine life. Until now, air has been considered something "used" but not necessarily "lived in" or critical to the survival of species. However, when air is considered habitat, RFR is among the potential pollutants with an ability to adversely affect other species. It is a new area of inquiry deserving of immediate funding and research.

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Electrosmog – What Price Convenience?

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and Theresa Morrow*

The public debates over tobacco, x-rays, and asbestos took over 100 years to officially settle public health issues. Today, we are witnessing the same debate over "electrosmog"— an ever-increasing, ubiquitous, invisible form of pollution generated by all-things-wireless and other technologies utilizing non-ionizing radiation.

Though many of the applied technologies are new, the debate is not. Back in 1971, the Electromagnetic Radiation Management Advisory Council to the White House warned that non-ionizing radiation was permeating our environment, that its growth since 1940 had been "phenomenal," and that there was concern for biological effects, even at low power levels. This was long before Motorola rolled out its consumer cell phone products beginning in 1983. Today over two billion cell phones are in use worldwide. Everything is going wireless, especially personal computer/Internet access. No government agency monitors the rising background levels of electromagnetic radiation (EMR), but the "smog" of it would become obvious if all those waves were suddenly made visible, filling the earth's surface, atmosphere, and ionosphere, penetrating every living cell — plant, animal, and human.

Non-ionizing radiation fills that section of the electromagnetic spectrum below visible light and includes infrared radiation (lasers, alarm systems, motion detectors), microwaves (cell phones, cordless phones, radar, smoke detectors, MRI, wireless Internet), broadcast applications (TV, FM and AM radio), down to the extremely low frequencies (ELF) of wired appliances and the earth's natural background. Current safety standards assume this non-ionizing radiation is safe if the power is too weak to heat living tissue. But since the 1980s, a growing body of research has found adverse effects below that thermal threshold – usually referred to as "non-thermal effects" – especially from long-term, low-level exposures. All of today's popular wireless technologies use the radio frequency (RF) bands, which include microwaves (MW) and ultra-high-frequency (UHF) wavelengths. A great deal of research has historically been done and continues in some countries – though regrettably no longer in the U.S. – to try to understand the complex picture of how these exposures interact with living tissue.

Industry Influence

The Telecom Industry quickly became one of the most influential industries in the world, second only to the oil and chemical cartels, and this was no accident. In 1984, after significant pressure, the telecoms were granted blanket exemption from "pre-market testing" of their products as long as they met certain guidelines. That's analogous to the FDA allowing untested drugs to be marketed without oversight. The telecoms have also managed to make a "partner" of the Federal Communications Commission (FCC). Today, the FCC sees its mandate less as regulatory and more as encouraging the rapid deployment of technology, including protecting the business interests of the companies they once regulated. Lobbyists for the telecom industry actually wrote Section 704 of the Telecom Act of 1996, which forbids municipalities from regulating the placement, construction, or modification of towers or antennas based on the environmental effects of RF if exposures are within FCC guidelines. However, not only are these guidelines among the most lenient in the world, but the FCC's budget for monitoring has also been slashed, so towers are simply not monitored for compliance. Whole cities are going WiFi. Such systems are categorically excluded from health review.

No Independent Research

At the same time the Telecom Act of '96 was passed and the FCC monitoring program slashed, the U.S. EPA's bioelectromagnetics research lab was also defunded. Today there is no research independent of the industry in America. And when the industry does sponsor research today, it's to shed doubt on studies that have found effects. Industry is on record as wanting to prove the technology is "safe," not on exploring potential hazard. Most research now comes from Europe and Asia. Years often pass before new information translates into public health recommendations. All the while technology develops at breakneck speed, far ahead of our understanding of potential effects.

Bioelectromagnetics:

The emerging picture of electromagnetic fields (EMFs) and the human anatomy is complex and disturbing. Both in the environment and in the body, EMFs can amplify and resonate. They can also cancel each other out or combine with other frequencies, creating a whole different exposure parameter. Magnetite, a mineral highly sensitive to EMFs, has been discovered in human brain tissue as well as in many animals, birds, and fish. All biological processes are likely electrical ones too. Dr. G. J. Hyland of The University of Warwick, U.K., and the International Institute of Biophysics in Neuss-Holzheim, Germany, calls the human body "an electrochemical instrument of exquisite sensitivity," noting that, like a radio, it can be interfered with by incoming radiation. He explains that modern digital technology pulses microwaves between 2 and 24 times per second. This pulsing is in the frequency range of our brain waves and can cause them to speed up or slow down, changing our level of consciousness, as has been demonstrated in electroencephalograms (EEG). Human brain tissue also reaches peak absorption in the ultra high frequency bands (UHF) – right where cellular technology functions. Both entrainment phenomena of brain waves and seizures have been observed in people exposed to UHF radiation.

In addition, resting EEG patterns have shown a shortening of REM sleep and a strengthening of alpha waves. In 1996, researchers K. Mann and J. Röschke in Neuropsychobiology, pointed out that "REM sleep plays a special physiological role for information processing in the brain." Several other studies have demonstrated learning disabilities in test animals exposed to low-level RF/MW, as well as an inability to remember what they have learned. One study in 1996 of children living near a radio station in Skrunda, Latvia showed they had significantly lower performance in memory, attention, motor function, reaction time, and neuromuscular endurance than control groups. Children are of special concern, as their immune systems are not yet developed, their brain wave patterns have not yet stabilized, their heads are smaller and their skulls thinner. Pregnant women, developing adolescents, the elderly, the otherwise ill, and those on certain medications are also more vulnerable. Dr. Henry Kues, at Johns Hopkins University, for instance, found in 1992 that glaucoma medications were affected by RF/MW radiation, making the eye more susceptible to damage. Magda Havas, Environmental Science Professor at Trent University, Canada, has shown that blood sugar levels in diabetics rise and fall with a change of electrical environment.

WHAT THEY DON'T TELL YOU - The human body is an electromechanical instrument which digital radiation can effect even causing cancers.

Of particular significance is the work of Drs. Henry Lai and N.P. Singh (Environmental Health Perspectives, May, 2004) that found both double and single strand DNA breaks, and the work of Drs. Martin Blank and Reba Goodman (Journal of Cellular Biochemistry, 2003) that found significant increases in heat shock proteins with low-level RF exposures. These studies, taken with others, indicate that there is little difference between non-ionizing and ionizing radiation such as that from x-rays. The only factor that counts to living tissue is the exposure duration and/or whether the anatomy has compensating mechanisms sufficient to repair damage before it becomes permanent. Research is beginning to indicate that there may be no safe threshold for these exposures, just like for x-rays. All signs point to the fact that long-term low level exposure to nonionizing radiation is just as detrimental as short-term high intensity exposures to ionizing radiation. And if that's the case, we are in trouble because non-ionizing radiation is everywhere and growing exponentially.

Sensitivity to RF/MW may accumulate over time, with some people becoming hypersensitive. Called "electromagnetic hypersensitivity syndrome" (EHS), Sweden now estimates that 3% of its population may be so afflicted. Swedes with EHS qualify for disability payments and government help to mitigate their living/work environments. EHS symptoms include headaches, dizziness, fatigue, insomnia, skin rashes and flushing. Onset can be gradual or sudden, such as when a cell tower is erected nearby or a WiFi computer is installed in one's home or even next door. Sweden now bans cell phone use on certain beaches so that people with EHS can enjoy those areas too.

One European study recommends cell towers be placed no closer than 300 meters (about 1000 feet) from homes. This is based on findings that 18 non-specific health symptoms - fatigue, memory problems, insomnia, headaches, irritability, libido decrease, and so on - decreased with distance from towers (R. Santini, Pathologic Biology, July

continued on page 8

Electrosmog – What Price Convenience?

continued from page 7

2002). The Connecticut Parents and Teachers Association (PTA) recommends a setback for cell towers and high-tension lines of 1500 feet from schools. But many studies show non-linear effects where the most negative impacts occur in unpredictable "windows" that are not always related to the strongest exposure.

One cancer that's universally accepted as directly related to cell phone use is acoustic neuroma (cancer of the nerve that connects the ear to brain), but both laboratory and epidemiological studies show a connection to numerous cancers. Associations have been found with cell phones and melanoma of the eye, salivary gland and neck tumors. RF exposures from broadcast facilities have been associated with brain tumors and leukemia. Most significantly, the European Union's REFLEX Project concluded in 2004 that chronic exposure to low-level EMFs can interfere with the body's ability to repair broken chromosomes. This leads to the formation of micronuclei, which is how many cancers begin.

And the non-human world is affected too. EMR can cause trees to lose leaves prematurely and become more susceptible to diseases. Evidence shows that RF/MW from cell, TV, and radio towers lowers milk production in cows, causes deformities in amphibians, lowers reproduction in animals and birds, and causes confusion, navigational disruption and death in migratory birds. Bees' navigational abilities are known to be sensitive to low-level EMFs. The U.S. Fish and Wildlife Service offers a conservative estimate that 4-to-5 million bird deaths per year result from bird collisions with towers. But RF maybe also be acting as an attractant to birds since their eye, beak and brain tissue is loaded with magnetite, a natural mineral highly sensitive to external magnetic fields that birds use in navigation. Noted American ornithologist, Robert Beason, discovered rapid neuronal firings in avian brain tissue exposed to cell-frequency RFs at very low intensities. There are also indications that RF may be contributing to global warming through the atmospheric agitation of hydrogen molecules in the upper atmosphere and ionosphere.

Precautionary Principle

The emerging picture is complex, variables are many, research is often hard to replicate, and studies often disagree. But one agreement is that far more research is needed. In the meantime, the reasonable approach is precaution. Lakehead University in Thunder Bay, Canada, recently banned WiFi Internet access from campus because there was not enough proof to show it is safe. The Public Health Commission of Salzburg, Austria, recommends that schools not use wireless networks. The Vienna Doctor's Chamber of Austria, The British Ministry of Health , and the Danish Health Council have warned against excessive use of mobile phones, especially by children. Their advice includes:

Headsets are not recommended. The wire can transmit the signal like an antenna.

Turn off the mobile phone at night—if left turned on, do not keep it near the head.

Play no games on the mobile phone.

Avoid carrying the mobile phone in the trousers pocket and sending text messages under the school desk; this can affect fertility.

Keep several meters' distance from people when making a call -- they are ir radiated by your cell phone too.

Use the Internet via cable connections. Wireless networks lead to high radiation exposure.

The International Commission for Electromagnetic Safety (ICEMS) met in Benevento, Italy, in February, 2006. Scientists from many nations, including the US, signed a resolution calling for precautionary strategies while research continues. They urge, among other things, that governments promote alternatives to wireless communication systems (like fiberoptics and coaxial cables), and inform the population of potential risks of wireless products. They also recommended wireless-free zones be designated in cities, public buildings and on public transit to allow people who are hypersensitive to EMF access.

The question is - why are Americans so clueless? The discussion in other countries about the environmental effects of nonionizing radiation is far in advance of our own today. Will we wait another 100 years before governments put true safety guidelines in place? Have we learned so little from our past mistakes with DDT, lead paint, tobacco, asbestos, and other forms of radiation that we cannot see electrosmog barreling down on us in electrons at the literal speed of light, carrying billions of human voices in mostly trivial conversations? What is the environmental price of a cell call home for the grocery list, or to say you will be delayed by a few minutes? What price convenience?

TURN IT OFF: - European doctors advise keeping a bed side cell phone away from your head and turning it off at night.

**B. Blake Levitt is an award-winning medical/science journalist, former New York Times writer and author of Electromagnetic Fields, A Consumer's Guide to the Issues and How to Protect Ourselves (Harcourt 1995). She lives in Litchfield County, CT.*

**Theresa Morrow, a musician, activist, and co-founder of Citizens Concerned About Wireless Technologies in Egremont, MA, died of breast cancer on May 20, 2007.*

To learn more:
Websites: The EMR Portal:
(for lists of scientific abstracts)
www.emf-portal.de/_index.php
The EMR Policy Institute:
www.EMRpolicy.org
Microwave News:
www.microwavenews.com
Council on Wireless Technology Impacts: www.energyfields.org
The Less EMF Catalog:
www.lessemf.com

***Books:** (Order information at www.blakelevitt.com)*

Special Interest:
www.iaff.org/safe/content/celltower/celltowerfinal.htm for a resolution by the International Association of Firefighters calling for a moratorium on cell tower placement on firehouses. And The Healthy Schools Network filed a friend of the court brief recommending prudent avoidance for cell towers on/near schools.

See www.EMRpolicy.org.

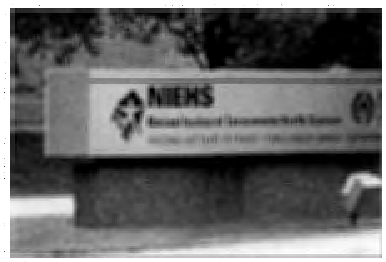
18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Friday, December 1, 2017

National Toxicology Program Finds Cell Phone Radiation Causes Cancer



Dec 1, 2017

Microwave News reported today that the vice-chair of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), Maria Feychting, has been trying to convince the scientific community to dismiss the $25 million cell phone cancer study conducted by the U.S. National Toxicology Program (NTP).

According to *Microwave News*, Feychting claimed at scientific meetings held in Germany and Sweden last month that the pathology analyses in the NTP study were not properly blinded. This issue was originally raised by an official reviewer of the study and was laid to rest in the NTP interim report released in May, 2016.

Several researchers in the U.S. and Europe expressed their concerns to *Microwave News* about Feychting's misguided efforts to undermine the credibility of the NTP cell phone study.

The *Microwave News* article reports that Feychting's declaration of personal interests filed with ICNIRP is incomplete as she has not fully disclosed potential conflicts of interest due to her role in the Swedish COSMOS study which has industry funding.

For more information see *Microwave News*.

Nov 28, 2017

NIEHS updates its cell phone information page

This month the National Toxicology Program (NTP) of the **National Institute of Environmental Health Sciences** (NIEHS) **updated the cell phone information page** on its website and the **fact sheet** which summarizes the NTP cell phone radiation study. See below for a summary of the study and its findings.

The NTP's website indicates that the NIEHS has warned its "federal regulatory partners" (i.e., the Federal Communications Commission and the Food and Drug Administration) that the NTP's research found that cell phone radiation caused cancer in male rats to enable these agencies to provide the latest guidance to the public about safe ways to use cell phones and other radiofrequency radiation-emitting devices.

Following is some of the language which now appears on the NTP website.

Joel M. Moskowitz, Ph.D.
Director
Center for Family and Community He
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety

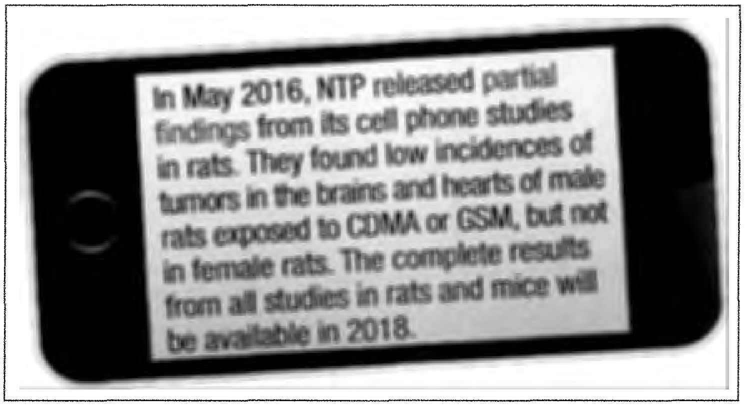
Archive

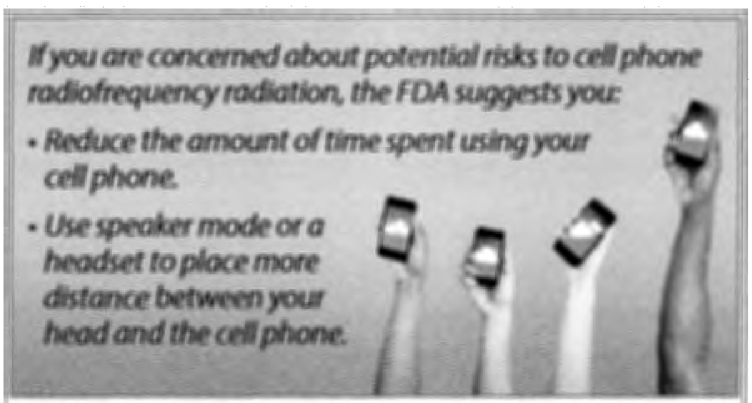
18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Here are some key points about the cell phone study:

- The nomination for NTP to study cell phone radiofrequency radiation was made by the U.S. Food and Drug Administration.
- These are the largest, most complex studies ever conducted by NTP.
- For the studies, rats and mice were exposed to frequencies and modulations currently used in cellular communications in the United States. The rodents were exposed for 10-minute on, 10-minute off increments, totaling just over 9 hours a day from before birth through 2 years of age.
- NTP found low incidences of tumors in the brains and hearts of male rats, but not in female rats. Studies in mice are continuing.
- NTP has provided these findings to its federal regulatory partners to enable them to have the latest information for public health guidance about safe ways to use cellular telephones and other radiofrequency radiation emitting devices.
- Previous human, observational data collected in earlier, large-scale population-based studies have found limited evidence of an increased risk for developing cancer from cell phone use.

The updated NTP **fact sheet** includes the following two graphics.





Nov 21, 2017

Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice

McCormick D. Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice. Toxicology Letters. 280 (Suppl. 1): S31. Oct 20, 2017. https://doi.org/10.1016/j.toxlet.2017.07.07

Epidemiology data concerning possible health effects of exposure to radiofrequency fields (RF) are conflicting. For this reason, well-designed and controlled studies in predictive laboratory animal models provide the best prospective opportunity to identify effects of RF exposure that may translate into human health hazards.

The U.S. National Toxicology Program supported a program in our laboratory to identify and characterize effects of acute, subchronic, and chronic exposure to non-thermal levels of RF in Sprague-Dawley rats and B6C3F1 mice.

Five-day pilot studies were performed to identify the maximum Specific Absorption Ratios (SARs) to which juvenile, adult, and pregnant rodents can be exposed without increasing body temperature by >1.0 °C.

Subsequent subchronic (ten-week) toxicity studies failed to identify any toxicologically significant effects of non-thermal RF on survival, body weight, clinical signs, hematology, or gross or microscopic pathology.

Two-year studies were performed to determine if exposure to non-thermal levels of RF increases the incidence of neoplasia in any site. Male rats exposed to RF demonstrated significantly increased incidences of glioma (brain) and schwannoma (heart); these increases were not seen in female rats or in either sex of mice.

Gliomas and schwannomas have been identified in some epidemiology studies as possible RF-induced neoplasms. Considering (a) the conflicting results of RF epidemiology studies and (b) the lack of generally accepted biophysical or molecular mechanisms through which RF could induce or promote neoplasia, data from animal bioassays will play a central role in "weight-of-the-evidence" assessments of the possible health effects of RF exposure.

http://www.sciencedirect.com/science/article/pii/S0378427417303120?via%3Dihub

Sep 20, 2017

Scientists from the National Toxicology Program presented their data on the genotoxicity of cell phone radiation in rats and mice at the annual meeting of the Environmental Mutagenesis and Genomics Society held in Raleigh, North Carolina from September 9-13, 2017.

Male and female rats and mice were exposed to 2G cell phone radiation, either CDMA or GSM, for 18 hours per day in 10 minute intervals. The rats were exposed to cell phone radiation at 1.5, 3, or 6 W/kg specific absorption rate (SAR) for 19 weeks from gestation day 5. The mice were exposed to radiation at 2.5, 5, or 10 W/kg SAR for 13 weeks from postnatal day 5.

DNA damage was assessed in three brain regions, in liver cells and in blood leukocytes using the comet assay. Chromosomal damage was assessed in peripheral blood erythrocytes using the micronucleus assay.

DNA damage was significantly increased:

- in the frontal cortex of male mice from either CDMA or GSM cell phone radiation exposure,
- in peripheral leukocytes of female mice from CDMA exposure, and
- in the hippocampus of male rats from CDMA exposure.

There were no significant increases in micronucleated red blood cells in rats or mice.

The authors concluded that, "exposure to RFR [radio frequency radiation] has the potential to induce measurable DNA damage under certain exposure conditions."

The NTP is scheduled to publish a complete report about its cell phone radiation studies in early 2018. The FDA called for this research in 1999.

Here is the abstract for this presentation.

P36

Evaluation of the Genotoxicity of Cell Phone Radiofrequency Radiation in Male and Female Rats and Mice Following Subchronic Exposure. Smith-Roe, SL1, Wyde ME[1], Stout MD[1], Winters JW[2], Hobbs CA[2], Shepard KG[2], Green AS[2], Kissling GA[1], Tice RR[1], Bucher JR[1], Witt KL[1], [1]NIEHS/NIH, Research Triangle Park, NC, United States, [2]Integrated Laboratory Systems, Inc., Research Triangle Park, NC, United States.

The National Toxicology Program tested the two common radiofrequency radiation (RFR) modulations emitted by cellular telephones in a 2-year rodent cancer bioassay that included additional animal cohorts for interim assessments of genotoxicity endpoints. Male and female Sprague Dawley rats and B6C3F1/N mice were exposed from gestation day 5 or postnatal day 35, respectively, to code division multiple access (CDMA) or global system for mobile (GSM) modulations semi-continuously for 18 h/day in 10 min intervals in reverberation chambers at specific absorption rates (SAR) of 1.5, 3, or 6 W/kg (rats) or 2.5, 5, or 10 W/kg (mice). Rats and mice were exposed at 900 MHz or 1900 MHz, respectively. The interim cohorts, 5 animals per treatment group, were examined after 19 (rats) or 13 (mice) weeks of exposure for evidence of RFR-induced genotoxicity. DNA damage was assessed in three brain regions (frontal cortex, hippocampus, and cerebellum), and in liver cells and blood leukocytes using the comet assay. Chromosomal damage was assessed in peripheral blood erythrocytes using the micronucleus assay. DNA damage was significantly increased in the frontal cortex of male mice (both modulations), peripheral leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). DNA damage was nominally elevated in several other tissues of RFR-exposed rats, although statistical significance was not achieved. No significant increases in micronucleated red blood cells were observed in rats or mice. These results suggest that exposure to RFR has the potential to induce measurable DNA damage under certain exposure conditions.

Paper presented at annual meeting of Environmental Mutagenesis and Genomics Society, Raleigh, North Carolina, September 9-13, 2017.

Aug 31, 2017

Microwave News reported that the National Toxicology Program (NTP) will release the "complete results" of its $25 million project on cell phone cancer risks early next year. The release of these data had been expected by the end of this year.

"The complete results from all the rat and mice studies will be available for peer review and public comment by early 2018," according to a new statement on the NTP Web site.

To date, the study has reported increased risk of cancer in the brain and heart of male rats from exposure to second generation (2G) cell phone radiation and increased risk of DNA damage in mice and rats of both sexes. For more information about the results of this study see the rest of this post.

This NTP project is our nation's only major research on the effects of cell phone radiation since the 1990's. The FDA recommended that the NTP conduct these toxicology and carcinogenicity studies in 1999. The FDA letter calling for this study can be downloaded from the NIEHS website.

The NTP is still studying the effects of 2G cellphone radiation which may soon be obsolete.

What about 3G, 4G, and 5G? Why must we rely on research from other nations to inform us about the health effects of this environmental toxin?

The Federal government should be held accountable for the lack of research in the U.S. on the health effects of wireless radiation since the 1990's.

Related Posts:

Government Failure to Address Wireless Radiation Risks
Industry-funded Scientists Undermine Cell Phone Radiation Science
An Exposé of the FCC: An Agency Captured by the Industries it Regulates
GAO 2012 Mobile Phone Report to the Congress
NTP: Not the First Govt. Study to Find Wireless Radiation Causes Cancer in Lab Rats
Storyline vs. Rest-of-the-story: Brain cancer incidence, cellphone use & trends data

April 4, 2017

According to ***Microwave News***, the National Toxicology Program (NTP) will not publish as a stand-alone paper its findings of increased DNA breaks among rats exposed to cell phone radiation. These data which have been reported at an international scientific conference will be incorporated in a technical report to be released in December. The report will provide a "final determination" about the level of evidence that cell phone radiation causes cancer.

The NTP's statement:

> "The genotoxicity paper was not accepted for stand-alone publication because the reviewers wanted additional detailed technical information on the methods used to expose the animals to radiofrequency radiation, as well as further placement of these findings in the context of the results of the two-year rodent studies. The complete results from all the rat and mice cancer studies remain in pathology review and the final determinations on the level of evidence for carcinogenic activity have not yet been made. For these reasons the decision was made to peer review and publish the genotoxicity data as part of the larger study in an NTP Technical Report."

For a summary of the evidence about DNA damage due to cell phone radiation see the posts below for June 10, 2016 and August 23, 2016.

September 7, 2016

The GREEN Gazette
Serving the Cariboo-Chilcotin, BC

HEALTH ISSUES | National Toxicology Program Report on Cancer Risk from Cellphone Radiation

The Green Gazette published an article today about the National Toxicology Program cell phone radiation study based upon my June 10 post which appears below.

http://www.thegreengazette.ca/health-issues-national-toxicology-program-report-on-cancer-risk-from-cellphone-radiation-2/

August 23, 2016

Presentation on NTP Study to NIEHS Board of Scientific Counselors

On June 15, Dr. Michael Wyde, the director of the cell phone radiation studies conducted by the National Toxicology Program (NTP), provided an overview of the studies to the Board of Scientific Counselors of the National Institute of Environmental Health Sciences (NIEHS). He summarized the research designs and the partial results for the toxicology and carcinogenicity studies.

A video of the presentation including the presentation slides and the question and answer session is available at https://youtu.be/TCRF71eMZ1Q.

According to Dr. Wyde, the FDA recommended that the NTP conduct toxicology and carcinogenicity studies of cell phone radiation in 1999. Completion of these studies is expected by some time in 2018.

The 1999 FDA letter calling for this study can be downloaded from the NIEHS website.

June 24, 2016

According to the National Institute of Environmental Health Sciences, the newly-released study on cellphone radiation and cancer in rats conducted by the National Toxicology Program (NTP) resulted in more than 1,000 news stories. Nearly 150 reporters participated in the telephone press conference held by the NTP on May 27.

Unfortunately, much of the media coverage contained considerable bias, or "spin" intended to create doubt about the study's important findings regarding cancer risk from exposure to cellphone radiation. Notable exceptions included news stories that appeared in the *Wall Street Journal* and *Mother Jones*.

June 10, 2016

NTP Toxicology & Carcinogenicity Cell Phone Radiofrequency Radiation Studies

Summary of Presentation at BioEM 2016 Meeting (Ghent, Belgium) by Michael Wyde, PhD, Director of NTP Studies of Cell Phone Radiation, NIEHS, June 8, 2016

Dr. Wyde explained the four reasons why the National Toxicology Program (NTP) decided to release partial study results at this time: 1) given widespread cellphone use, even a small increase in disease incidence could have major public health implications; 2) there is a high level of public and media interest in the study; 3) the tumor types observed in these studies are similar to those found in human studies of cellphone use; and 4) the results support the IARC classification of radiofrequency radiation as potentially cancer-causing in humans.

Dr. Wyde discussed the 5-day pilot studies conducted on young and aged mice and rats and on pregnant rats to determine the maximum intensity of cellphone radiation that could be employed in the subsequent studies without inducing any heating effect. He also described the 28-day pre-chronic toxicology studies and the 2-year toxicology and carcinogenicity studies.

For the pre-chronic studies, NTP selected SAR exposures of 0, 3, 6, and 9 watts/kilogram (W/kg) in rats and 0, 5, 10, and 15 W/kg in mice based on pilot study results. Pregnant rats were exposed prenatally and 28 days postnatal to 900 MHz cellphone radiation (GSM or CDMA). Five-week old mice were exposed to 1900 MHz cellphone radiation for 28 days.

Dr. Wyde reported **statistically significant evidence of DNA damage from nonthermal exposure to cellphone radiation in mice as well as in rats:**

- male rats: frontal cortex, hippocampus, liver, blood
- male mice: frontal cortex
- female rats: frontal cortex
- female mice: liver, blood

The partial results of the carcinogenicity studies were also discussed. See my summary below.

The slides for this presentation are available at:
http://ntp.niehs.nih.gov/ntp/research/areas/cellphone/slides_bioem_wyde.pdf

June 13, 2016

Do Cellphones Cause Cancer? Probably, but it's Complicated
Dr. Chris Portier, Scientific American Blog, Jun 13, 2016

Setting the Record Straight on NTP Cell Phone Cancer Study
Dr. Ron Melnick Corrects 'Misinformation,' Rebuffed by the New York Times
Microwave News, Jun 10, 2016

May 30, 2016

SPIN vs FACT: *National Toxicology Program* report on cancer risk from cellphone radiation

The National Toxicology Program (NTP) of the National Institutes of Health reported partial findings from their $25 million study of the cancer risk from cellphone radiofrequency radiation (RFR). Controlled studies of rats showed that RFR caused two types of tumors, glioma and schwannoma. The results "...could have broad implications for public health."

A fact sheet on the NTP study that summarizes some biased statements, or "Spin," about the study that tend to create doubt about data quality and implications, as well as "Facts" from decades of previous research is available at http://bit.ly/NTPspinfacts.

A German translation of this fact sheet is available at **diagnose:funk**. An Italian translation is available at **Amica Associazione.**

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School of Public Health, University of California, Berkeley

Website
Facebook
Twitter: @berkeleyprc

SPIN vs FACT: *National Toxicology Program* report on cancer risk from cellphone radiation

The National Toxicology Program (NTP) of the National Institutes of Health partial findings from their $25 million study of the cancer risk from cellphone radiofrequency radiation (RFR). Controlled studies of rats showed that RFR caused two types of tumors, glioma and schwannoma. The results "...could have broad implications for public health." Below are some biased statements, or "Spin," about the study that tend to create doubt about data quality and implications, as well as "Facts" from decades of previous research.

SPIN	FACT
Conclusions are faulty. Dr. Michael Lauer, deputy director for extramural research at the National Institutes of Health. "I am unable to accept the authors' conclusions."	The NTP is world-renowned for toxicology research. This is toxicology study of RFR carcinogenic effects. Criticisms by Dr. Lauer and other scientists who reviewed the study were **rebutted in the study report.**
Study reports a "low incidence" of tumors in the brain and heart in rats exposed to RFR.	The study found that **one in twelve (8.5%)** of the 540 male rats exposed to cellphone radiation developed **cancer or pre-cancerous cells** as compared to none of the 90 rats in the control condition.
Relevance of animal studies to humans is questionable.	The cells that developed tumors are the **same cells** that display elevated tumor risk in studies of long-term, **heavy cellphone users**. Rats are the for carcinogenicity studies.
IARC), rated **cellphone radiation a "possible" human carcinogen (Group 2B), the same rating given to coffee, pickled vegetables, and talc.**	The report provides strong evidence that RFR exposure causes cancer published since the 2011 IARC meeting consistently find that long-term, heavy cellphone users have increased risk of brain tumors. Group **2B carcinogens also include DDT, lead, and diesel fumes.**
Prior research contradicts NTP study results (e.g. British .	The Danish study has been criticized by many scientists for excluding heavy cellphone users. The British Study has also been criticized; but, it found **evidence for acoustic neuroma** (a form of schwannoma).
Epidemiological studies fail to show an increase in brain tumor incidence since 1992 even though cellphone use has mushroomed.	The n the U.S. since cellphones. Moreover, the the most serious type of brain cancer, has increased in **parts of the brain proximal to where cellphones are held.** Brain cancer can take decades to develop, so it is premature to see overall increases in malignant tumors in the general population.
There is no mechanism to explain how cellphones could cause cancer. Unlike ionizing radiation, *non-ionizing* radiation from cellphones cannot damage DNA.	A reported that in 93 of 100 studies **RFR produced a cellular stress response** which can lead to DNA damage and cancer. The NTP study also found evidence of Several present evidence for different mechanisms by which RFR may cause cancer.
The research has not been peer-reviewed.	The NTP report has been peer-reviewed by experts. Some **reviews appear in the report** along with the authors' responses.
Findings are preliminary, it is premature to conclude we should take precautions or change policy.	These are not preliminary findings. According to NTP, the effects of RFR on these two tumors, glioma and schwannoma, are final. The federal government released this because the results "could ead **cellphone use.** The NTP posted on its reduce cellphone radiation exposure.

Page 1 / 1

May 27, 2016 (updated June 1)

On May 26, the National Toxicology Program (NTP) of the National Institutes of Health issued the first in a series of reports that contains partial findings from their long-awaited, $25 million study of the cancer risk from cell phone radiation. This report summarizes the study of long-term exposure to cell phone radiation on rats. The report on mice will be issued at a later date.

According to the report:

> "Given the widespread global usage of mobile communications among users of all ages, even a very small increase in the incidence of disease resulting from exposure to RFR [radiofrequency radiation] could have broad implications for public health."

Overall, thirty of 540 (5.5%), or **one in 18 male rats exposed to cell phone radiation developed cancer**. In addition,16 pre-cancerous hyperplasias were diagnosed. Thus, 46 of 540, or **one in 12 male rats exposed to cell phone radiation developed cancer or pre-cancerous cells** as compared to none of the 90 unexposed male rats.

The two types of cancer examined in the exposed rats were glioma and schwannoma. Both types have been found in human studies of cell phone use.

In the group exposed to the **lowest intensity of cell phone radiation** (1.5 watts/kilogram or W/kg), 12 of 180, or **one in 15 male rats** developed cancer or pre-cancerous cells. In the **highest exposure** group (6 W/kg), 24 of 180, or **one in 8 male rats** developed cancer or pre-cancerous cells.

This latter finding has policy implications for the FCC's current cell phone regulations which allow cell phones to emit up to 1.6 W/kg at the head or near the body (partial body Specific Absorption Rate or SAR).

The NTP study is likely a **"game-changer"** as it proves that non-ionizing, radiofrequency radiation can cause cancer without heating tissue.

The results of the study reinforce the need for more stringent regulation of radiofrequency radiation and better disclosure of the health risks associated with wireless technologies -- two demands made by the **International EMF Scientist Appeal** -- a petition signed by 220 scientists who have published research on the effects of electromagnetic radiation.

Along with other recently published studies on the biologic and health effects of cell phone radiation, the International Agency for Research on Cancer of the World Health Organization should now have sufficient data to reclassify radiofrequency radiation from "possibly carcingogenic" to "probably carcinogenic in humans."

The risk of cancer increased with the intensity of the cell phone radiation whereas no cancer was found in the sham controls— rats kept in the same apparatus but without any exposure to cell phone radiation.

In contrast to the male rats, the incidence of cancer in **female rats** among those exposed to cell phone radiation was not statistically significant. Overall, sixteen of 540 (3.0%), or **one in 33 female rats exposed to cell phone radiation developed cancer or a pre-cancerous lesion** as compared to none of the 90 unexposed females. The NTP provided no explanation for the sex difference. The researchers pointed out that none of the human epidemiology studies has analysed the data by sex.

Why did cellphone radiation significantly increase cancer risk in male but not female rats? Perhaps, because glioma and heart schwannoma are less common in females. According to *Microwave News* (6/1/2016), the NTP report shows that among controls from past toxicology studies, males were ten times more likely to develop glioma than female rats (11 of 550 vs. 1 of 540). Also, males were twice as likely to develop heart schwannoma than female rats (9 of 669 vs. 4 of 699).

The researchers believe that the cancers found in this experimental study were caused by the exposure to cell phone radiation as none of the control animals developed cancer. The researchers controlled the temperature of the animals to prevent heating effects so the cancers were caused by a **non-thermal mechanism.**

One of two types of second-generation (2G) cell phone technology, GSM and CDMA, were employed in this study. The frequency of the signals was 900 MHz. The rats were exposed to cell phone radiation every 10 minutes followed by a 10-minute break for 18 hours, resulting in nine hours a day of exposure over a two-year period. Both forms of cell phone radiation were found to increase cancer risk in the male rats.

For each type of cell phone radiation, the study employed four groups of 90 rats -- a sham control group that was not exposed to radiation, and three exposed groups. The lowest exposure group had a SAR of 1.5 W/kg which is within the FCC's legal limit for partial body SAR exposure (e.g., at the head) from cell phones. The other exposure groups had SARs of 3 and 6 W/kg.

Glioma is a common type of brain cancer in humans. It affects about 25,000 people per year in the U.S. and is the most common cause of cancer death in adults 15-39 years of age. Several major studies have found increased risk of glioma in humans associated with long-term, heavy cell phone use.

In humans, schwannoma is a nonmalignant tumor that grows in Schwann cells that cover a nerve which connects to the brain. Numerous studies have found an increased risk of this rare tumor in heavy cell phone users. In the rat study, malignant schwannoma was found in Schwann cells in the heart.

The FDA requested in May, 1999 that the NIEHS research the effects of cell phone radiation on DNA in animal models. FDA called this a "high priority." Seventeen years later the NIEHS has released only partial results from a series of studies which should have taken only a few years to conduct.

For more information about the NTP study see http://bit.ly/govtfailure.

For references to the research that found increased risk of malignant and nonmalignant tumors among long-term cell phone users see http://bit.ly/WSJsaferemr.

The NTP report is available at http://bit.ly/NTPcell1.

G+

Labels: Bucher, cancer, cell phone radiation, game-changer, glioma, mice, National Toxicology Program, NIEHS, NIH, NTP Study, rats, report, schwannoma, Wyde

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18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Tuesday, December 26, 2017

Thyroid Cancer & Mobile Phone Use

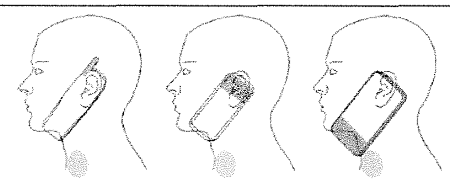


Fig. 10 Mobile phone antenna placements in regard to the thyroid gland

From: Carlberg et al. 2016 (see abstract below).

Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013

H Lim, SS Devesa, JA Sosa,et al D Check,CM Kitahara, Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013. JAMA. Published online March 31, 2017. doi:10.1001/jama.2017.2719

Key Points

Question What have been the trends in US thyroid cancer incidence and mortality, and have they differed by tumor characteristics at diagnosis?

Findings In this analysis of 77,276 thyroid cancer patients diagnosed during 1974-2013 and of 2,371 thyroid cancer deaths during 1994-2013, average annual increases in incidence and mortality rates, respectively, were 3.6% and 1.1% overall and 2.4% and 2.9% for patients diagnosed with advanced-stage papillary thyroid cancer.

Meaning Thyroid cancer incidence and mortality rates have increased for patients diagnosed with advanced-stage papillary thyroid cancer in the United States since 1974, suggesting a true increase in the occurrence of thyroid cancer.

Abstract

Importance Thyroid cancer incidence has increased substantially in the United States over the last 4 decades, driven largely by increases in papillary thyroid cancer. It is unclear whether the increasing incidence of papillary thyroid cancer has been related to thyroid cancer mortality trends.

Objective To compare trends in thyroid cancer incidence and mortality by tumor characteristics at diagnosis.

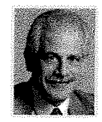
Design, Setting, and Participants Trends in thyroid cancer incidence and incidence-based mortality rates were evaluated using data from the Surveillance, Epidemiology, and End Results-9 (SEER-9) cancer registry program, and annual percent change in rates was calculated using log-linear regression.

Exposure Tumor characteristics.

Main Outcomes and Measures Annual percent changes in age-adjusted thyroid cancer incidence and incidence-based mortality rates by histologic type and SEER stage for cases diagnosed during 1974-2013.

Results Among 77 276 patients (mean [SD] age at diagnosis, 48 [16] years; 58 213 [75%] women) diagnosed with thyroid cancer from 1974-2013, papillary thyroid cancer was the most common histologic type (64 625 cases), and 2371 deaths from thyroid cancer occurred during 1994-2013. Thyroid cancer incidence increased, on average, 3.6% per year (95% CI, 3.2%-3.9%) during 1974-2013 (from 4.56 per 100 000 person-years in 1974-1977 to 14.42 per 100 000 person-years in 2010-2013), primarily related to increases in papillary thyroid cancer (annual percent change, 4.4% [95% CI, 4.0%-4.7%]). Papillary thyroid cancer incidence increased for all SEER stages at diagnosis (4.6% per year for localized, 4.3% per year for regional, 2.4% per year for distant, 1.8% per year for unknown). During 1994-2013, incidence-based mortality increased 1.1% per year (95% CI, 0.6%-1.6%) (from 0.40 per 100 000 person-years in 1994-1997 to 0.46 per 100 000 person-years in 2010-2013) overall and 2.9% per year (95% CI, 1.1%-4.7%) for SEER distant stage papillary thyroid cancer.

Conclusions and Relevance Among patients in the United States diagnosed with thyroid cancer from 1974-2013, the overall incidence of thyroid cancer increased 3% annually, with increases in the incidence rate and thyroid cancer mortality rate for advanced-stage papillary thyroid cancer. These findings are consistent with a true increase in the occurrence of thyroid cancer in the United States.



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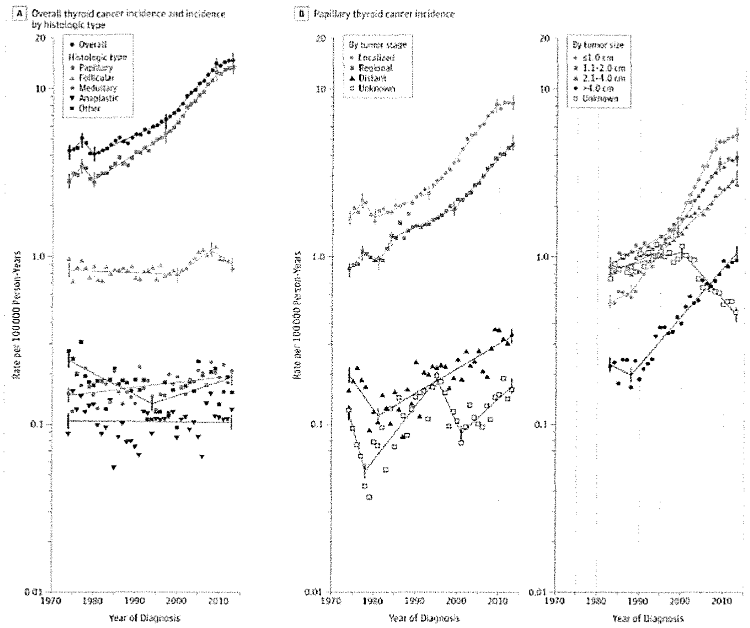
University of California, Berkeley

Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18



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Korea's Thyroid-Cancer "Epidemic" — Screening and Overdiagnosis (and wireless phone use?)

November 5, 2014

According to today's issue of the ***New England Journal of Medicine***, South Korea has experienced a thyroid cancer epidemic in recent years (see paper and Figure below).

> "Thyroid cancer is now the most common type of cancer diagnosed in South Korea."

The authors of this paper attribute the "epidemic" to a government-sponsored cancer screening program. As evidence, they report,

> "There was a strong correlation between the proportion of the population screened in a region in 2008 and 2009 and the regional incidence of thyroid cancer in 2009. Although the aggregate correlation could be vulnerable to the ecologic fallacy, the finding of significant positive correlations in each of eight age- and sex-based groups suggests that the finding is more robust."

That widespread screening identifies more cancer is not surprising. This could at least partly explain the increasing incidence of thyroid cancer observed in South Korea, and nine other countries including the U.S.

The authors argue that most of these cancers are not life-threatening and advise other countries against widespread screening for thyroid cancer:

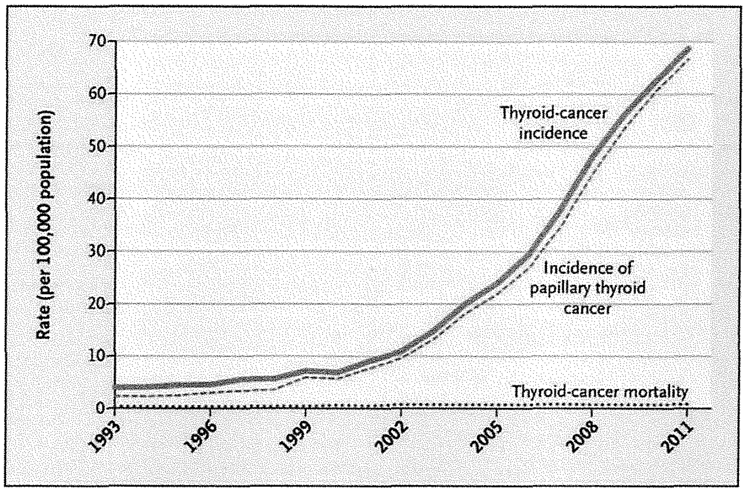
> "The experience with thyroid-cancer screening in South Korea should serve as a cautionary tale for the rest of the world. During the past two decades, multiple countries have had a substantial increase in thyroid-cancer incidence without a concomitant increase in mortality. According to the Cancer Incidence in Five Continents database maintained by the International Agency for Research on Cancer, the rate of thyroid-cancer detection has more than doubled in France, Italy, Croatia, the Czech Republic, Israel, China, Australia, Canada, and the United States. The South Korean experience suggests that these countries are seeing just the tip of the thyroid-cancer iceberg — and that if they want to prevent their own "epidemic," they will need to discourage early thyroid-cancer detection."

I'm not sure the answer is to simply ignore these cancers, but I don't want to address that debate here.

Rather, I would like to focus on the question why has thyroid cancer become so prevalent in at least ten nations? According to the American Cancer Society, although some thyroid cancers are linked to exposure to ionizing radiation, "the exact cause of most thyroid cancers is not yet known."

Could exposure to the electromagnetic radiation (RF and ELF) emitted by cell phones and cordless phones be contributing to this worldwide thyroid cancer epidemic? Isn't time for our government to fund research on the risk factors underlying this epidemic?

Hyeong Sik Ahn, Hyun Jung Kim, H. Gilbert Welch. Korea's Thyroid-Cancer "Epidemic" — Screening and Overdiagnosis. N Engl J Med 2014; 371:1765-1767 November 6, 2014DOI: 10.1056/NEJMp1409841



Is mobile phone use contributing to increased incidence of thyroid cancer?

July 9, 2014

The incidence of thyroid cancer has been increasing rapidly in recent years in many countries including the U.S., Canada, and Israel.

A headline in *Haaretz* a year ago March reads, **"Israeli scientists find possible link between cellphone use, thyroid cancer."**

In response to questions posed to me on this topic today from several individuals, I did a PubMed search. Although I did not find any epidemiologic studies that examined the association between mobile phone use and thyroid cancer in humans, I found almost a dozen published papers that have studied the effects of cell phone radiation on thyroid function. Apparently, case-control research on this topic is warranted.

The abstracts from 11 published papers that examined the effects of exposure to cell phone radiation on thyroid function appear below. Please let me know if you are aware of important studies that I missed, and I will supplement this list. I did not include studies that examined exposure to power frequency radiation.

But first, here is the 2013 news article ...

Israeli scientists find possible link between cellphone use, thyroid cancer

Dan Even, Haaretz, Mar 6, 2013

Israeli scientists have reported preliminary findings of a possible link between the radiation from cellphones and thyroid cancer. There has been a steep rise in rates of thyroid cancer in recent years in Western countries.

The Israeli research, conducted at Beilinson Hospital in Petah Tikva and at Tel Aviv University, identified evidence for the first time of the possible connection between the rise in thyroid cancer cases to the increased exposure to radiation emitted by cellphones.

In one experiment, human thyroid cells collected from healthy patients were subjected to radiation with a device, designed for the study, that simulates the electromagnetic radiation emitted by cellphones. The irradiated thyroid cells proliferated at a much higher, statistically significant rate than non-irradiated cells in the control group. A second experiment, using different methods and materials, gave similar results.

The research was conducted in the Felsenstein Medical Research Center, part of the Sackler Faculty of Medicine at Tel Aviv University and the Rabin Medical Center. Prof. Raphael Feinmesser, head of Beilinson's Ear, Nose and Throat Department was the lead researcher. The findings will be presented for the first time this weekend at the annual conference of the Israeli Society of Otolaryngology, Head and Neck Surgery, in Eilat.

"The findings are the first evidence of changes in thyroid cells in response to electromagnetic radiation," said Feinmesser. "But drawing sweeping conclusions as to a connection between cellphone radiation and thyroid cancer is still far off."

The scientific community is divided as to the connection between cellular radiation and cancer. One opinion is that because cellular radiation is non-ionizing and incapable of causing changes in cellular DNA, it cannot cause cancer. But in recent years evidence has mounted from epidemiological studies indicating a relationship between increased exposure to cellular radiation and cancerous growths, especially in the brain and the salivary glands.

"The thyroid gland is located in the neck, but the area is located the same distance from the ear as the regions of the brain where [cancerous] growths have been diagnosed as being related to the use of the [cellular] devices. This is a region that is not far from the center of the device's radiation," said Feinmesser.

The incidence of thyroid cancer has been on the rise in Israel for more than a decade, which matches the rise in the use of cellphones. Thyroid cancer is three times more common in women than men. It is the fourth most common form of cancer among Jewish women in Israel, at 16.6 cases per 100,000 people. The three most common forms of cancer for women are cancer of the breast, colon and cervix. Among Israeli Arab women the rate of thyroid cancer is 11.6 cases per 100,000, and it is the third most common cancer. From 1990 to 2007 there was a 67-percent rise in thyroid cancer rates among Jewish women, and a 250 percent increase among Arab women, Health Ministry figures show. For men, the rise from 2000 is more moderate, but still shows a 41 percent increase in thyroid cancer rates for Jewish men.

"One of the explanations is that the rise is related to better technical methods of early detection of these growths, which have been developed in recent years. But other research shows that even after neutralizing this influence a rise in these growths still remains," said Feinmesser.

Just this week it was reported that mobile operator Partner Communications (Orange) reached a settlement with a customer who claims he contracted cancer after using the company's cellphones. The customer, who is in his 50s, sued Partner in May, claiming that intensive use of the device resulted in an aggressive lymphoma near his left ear. Partner agreed to pay NIS 400,000 in an out-of-court settlement."

http://bit.ly/14rrWfA

Recent Studies

Baby NM, Koshy G, Mathew A. The Effect of Electromagnetic Radiation due to Mobile Phone Use on Thyroid Function in Medical Students Studying in a Medical College in South India. Indian J Endocrinol Metab. 2017 Nov-Dec;21(6):797-802.

Abstract

Background: Enormous increase in mobile phone use throughout the world raises widespread concerns about its possible detrimental effect on human health. Radiofrequency waves are emitted by cell phones. They are non-ionising and the effect on the thyroid gland is part of their non thermal effects. The thyroid gland may be particularly vulnerable to this effect because of its normal anatomical position.

Materials and Methods: The study was done to explore the association between radiation exposure and thyroid dysfunction among mobile phone users. It had an exploratory design and unit survey method to collect information from all medical students in a medical college in South India. Inclusion criteria included active use of mobile phone prior to and during the study period. Criteria for exclusion was presence of pre-existsting thyroid disease,thyroid nodule,thyroid goitre/nodule and altered thyroid function.

Results: The sample size was 83 undergraduate students. 71% of respondents had no family history of thyroid illness. Among the remainder,20.5% had a first degree relative with thyroid dysfunction,8.4% had a second degree relative affected. Clinical examination revealed that 79.5% of the respondents were normal,13.6% had thyroid swelling,3.6% had symptoms of thyroid dysfunction and 3.6% had both thyroid swelling and symptoms of thyroid dysfunction. 53% of the respondents spent 0.5 hrs on an average talking on the phone daily,28.9% spent 1.5 hrs daily and 10.8% of respondents spent over 3.5 hours. We found there was a significant correlation between total radiation exposure and an increase in TSH among both groups -in those with and without family history of thyroid illness.

Conclusion: In our study there was a significant correlation between total radiation exposure and increasing TSH values among both all respondents.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5729662/

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Silva V, Hilly O, Strenov Y, Tzabari C, Hauptman Y, Feinmesser R. Effect of cell phone-like electromagnetic radiation on primary human thyroid cells. Int J Radiat Biol. 2016;92(2):107-15. Epub 2015 Dec 21.

Abstract

PURPOSE: To evaluate the potential carcinogenic effects of radiofrequency energy (RFE) emitted by cell phones on human thyroid primary cells.

MATERIALS AND METHODS: Primary thyroid cell culture was prepared from normal thyroid tissue obtained from patients who underwent surgery at our department. Subconfluent thyroid cells were irradiated under different conditions inside a cell incubator using a device that simulates cell phone-RFE. Proliferation of control and irradiated cells was assessed by the immunohistochemical staining of antigen Kiel clone-67 (Ki-67) and tumor suppressor p53 (p53) expression. DNA ploidy and the stress biomarkers heat shock protein 70 (HSP70) and reactive oxygen species (ROS) was evaluated by fluorescence-activated cell sorting (FACS).

RESULTS: Our cells highly expressed thyroglobulin (Tg) and sodium-iodide symporter (NIS) confirming the origin of the tissue. None of the irradiation conditions evaluated here had an effect neither on the proliferation marker Ki-67 nor on p53 expression. DNA ploidy was also not affected by RFE, as well as the expression of the biomarkers HSP70 and ROS.

CONCLUSION: Our conditions of RFE exposure seem to have no potential carcinogenic effect on human thyroid cells. Moreover, common biomarkers usually associated to environmental stress also remained unchanged. We failed to find an association between cell phone-RFE and thyroid cancer. Additional studies are recommended.

https://www.ncbi.nlm.nih.gov/pubmed/26689947

Note: This study did not expose the cell samples to cell phone radiation. The RFE exposure in this simulation did not resemble cell phone radiation.
"Subconfluent thyroid cells were irradiated ... using a device consisting of a Radio Frequency (RF) generator (Fluke 60602A, manufactured by Fluke, Everett, WA) and an RF power amplifier (EMPower 7044, Holbrook, NY). The RF generator, located outside the incubator, was set to the desired power and connected to the power amplifier, which was connected to a panel antenna that was fixed inside the incubator."

"... an antenna was placed inside the cell incubator and set at 900 or 895 MHz and 80 or 210 μW/cm^2 to simulate the radiation emitted by mobile phones."

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International Agency for Research on Cancer. Overdiagnosis is a major driver of the thyroid cancer epidemic: Up to 50-90% of thyroid cancers in women in high-income countries estimated to be overdiagnoses. Press Release No. 246. August 18, 2016. http://www.iarc.fr/en/media-centre/pr/2016/pdfs/pr246_E.pdf

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Lu M, W XY. Study of specific absorption rate (SAR) induced in human endocrine glands for using mobile phones. IEEE Asia-Pacific International Symposium on Electromagnetic Compatibility (APEMC), 2016.: 1084-1086. (Journal not peer-reviewed)

Abstract

With the quick development and widespread use of mobile phones has led to a rising concern about the possible adverse health effects of radio frequency electromagnetic field exposure. This study aims to present the dosimetry analysis of the electromagnetic fields induced by mobile phone on human endocrine glands. A finite-difference time-domain (FDTD) method was employed to calculate the specific absorption rate (SAR) in a realistic human head-neck model from exposure to a generic handset at 1750 MHz. The results show that the locally induced SAR in thyroid gland is much larger than that in both hypophysis and hypothalamus glands. The induced SAR in thyroid for the mobile in short message service (SMS) position is much larger than that in the voice position. However, in all of the examined cases, the SAR values in endocrine glands are all below the IEEE safety standard.

Conclusion

In this work, SAR depositions in realistic human endocrine glands have been analysed when they were exposed to the electromagnetic radiation from a mobile phone. It was found the induced SAR in thyroid gland is much larger than that in hypophysis and hypothalamus glands when the mobile was placed in both voice and SMS positions. Although the induced SAR in the human endocrine glands are below the IEEE safety standard, long-term use of mobile with the higher level SAR absorption in thyroid gland may be a risk factor associated with several thyroid disorders.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7522951

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Carlberg M, Hedendahl L, Ahonen, Koppel T, Hardell L. Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data. BMC Cancer. 16:246. 2016.

Abstract

Background: Radiofrequency radiation in the frequency range 30 kHz–300 GHz was evaluated to be Group 2B, i.e. 'possibly' carcinogenic to humans, by the International Agency for Research on Cancer (IARC) at WHO in May 2011. Among the evaluated devices were mobile and cordless phones, since they emit radiofrequency electromagnetic fields (RF-EMF). In addition to the brain, another organ, the thyroid gland, also receives high exposure. The incidence of thyroid cancer is increasing in many countries, especially the papillary type that is the most radiosensitive type.

Methods: We used the Swedish Cancer Register to study the incidence of thyroid cancer during 1970–2013 using joinpoint regression analysis.

Results: In women, the incidence increased statistically significantly during the whole study period; average annual percentage change (AAPC) +1.19 % (95 % confidence interval (CI) +0.56, +1.83 %). Two joinpoints were detected, 1979 and 2001, with a high increase of the incidence during the last period 2001–2013 with an annual percentage change (APC) of +5.34 % (95 % CI +3.93, +6.77 %). AAPC for all men during 1970–2013 was +0.77 % (95 % CI −0.03, +1.58 %). One joinpoint was detected in 2005 with a statistically significant increase in incidence during 2005–2013; APC +7.56 % (95 % CI +3.34, +11.96 %). Based on NORDCAN data, there was a statistically significant increase in the incidence of thyroid cancer in the Nordic countries during the same time period. In both women and men a joinpoint was detected in 2006. The incidence increased during 2006–2013 in women; APC +6.16 % (95 % CI +3.94, +8.42 %) and in men; APC +6.84 % (95 % CI +3.69, +10.08 %), thus showing similar results as the Swedish Cancer Register. Analyses based on data from the Cancer Register showed that the increasing trend in Sweden was mainly caused by thyroid cancer of the papillary type.

Conclusions: We postulate that the whole increase cannot be attributed to better diagnostic procedures. Increasing exposure to ionizing radiation, e.g. medical computed tomography (CT) scans, and to RF-EMF (non-ionizing radiation) should be further studied. The design of our study does not permit conclusions regarding causality.

Open access paper: https://bmccancer.biomedcentral.com/articles/10.1186/s12885-016-2429-4

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Silva V, Hilly O, Strenov Y, Tzabari C, Hauptman Y, Feinmesser R. Effect of cell phone-like electromagnetic radiation on primary human thyroid cells. Int J Radiat Biol. 92(2):107-115. 2016.

My comments: The exposures in this study were rather low as the maximum SAR was 0.170 W/kg. The exposures in the three experimental conditions ranged from 895 to 900 Mhz, 80 to 210 $\mu W/cm^2$ power density, and 0.082 to 0.170 W/kg SAR.

Abstract

Purpose To evaluate the potential carcinogenic effects of radiofrequency energy (RFE) emitted by cell phones on human thyroid primary cells.

Materials and methods Primary thyroid cell culture was prepared from normal thyroid tissue obtained from patients who underwent surgery at our department. Subconfluent thyroid cells were irradiated under different conditions inside a cell incubator using a device that simulates cell phone-RFE. Proliferation of control and irradiated cells was assessed by the immunohistochemical staining of antigen Kiel clone-67 (Ki-67) and tumor suppressor p53 (p53) expression. DNA ploidy and the stress biomarkers heat shock protein 70 (HSP70) and reactive oxygen species (ROS) was evaluated by fluorescence-activated cell sorting (FACS).

Results Our cells highly expressed thyroglobulin (Tg) and sodium-iodide symporter (NIS) confirming the origin of the tissue. None of the irradiation conditions evaluated here had an effect neither on the proliferation marker Ki-67 nor on p53 expression. DNA ploidy was also not affected by RFE, as well as the expression of the biomarkers HSP70 and ROS.

Conclusion Our conditions of RFE exposure seem to have no potential carcinogenic effect on human thyroid cells. Moreover, common biomarkers usually associated to environmental stress also remained unchanged. We failed to find an association between cell phone-RFE and thyroid cancer. Additional studies are recommended.

Conclusions

We here report that different evaluated RFE exposure conditions have no potential carcinogenic effect on thyroid cells. Proliferation and cellular DNA integrity, two major players in cancer development and progression were not affected in our conditions. Moreover, common biomarkers that are usually associated with environmental stress also remained unchanged after RFE irradiation. Among the limitations of our work we consider that even though measurements of extremely low frequency interference were considerably low, the stray magnetic fields emitted by the instruments used in the study may have had a confounder effect on our results. On the other hand, different conditions of time and frequencies of exposure should be further explored in order to completely cross out a deleterious effect of RFE on thyroid cells. In summary, the increase of both, thyroid cancer and cellular phone use calls the attention to further investigate the potential effects that chronic use of mobile phones might have on the thyroid gland.

http://1.usa.gov/1QKkvx9

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Hilly, Ohad; Silva, Verónica; Mizrachi, Aviram; Ariel, Ortal; Raiter, Annat; Hauptman, Yirmi; Hardy, Britta; Feinmesser, Raphael. EFFECT OF NON-IONIZING ELECTROMAGNETIC RADIATION AT MOBILE PHONE FREQUENCY ON HUMAN THYROID CELLS. Abstract from the World Thyroid Cancer Congress in Toronto 2013.

Background/Purpose: The aim of this study was to examine the effect of non-ionizing electromagnetic radiation (NIER) at mobile phone frequency on human thyroid cells.

Methods: We cultured samples of normal thyroid tissue and subsequently exposed the cultured thyrocytes to NIER for 3 hours. NIER effects were evaluated in terms of proliferation using a cell viability assay and immunohistochemistry.

Results: We found that NIER exposure for 3 hours has lead to an increased proliferation of thyrocytes in cell viability assay ($p=0.007$). This result was confirmed by immunohistochemistry with antibodies against Ki67.

Discussion & Conclusion: In this study we present for the first time an in vitro evaluation of NIER effects on human thyroid cells. Our results suggest a proliferative effect of NIER on human thyrocytes, an effect that may link NIER exposure with potential carcinogenesis.

http://thyroidworldcongress.com/wp-content/uploads/2013/07/O022_Mizrachi.pdf

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Exposure to non-ionizing radiation provokes changes in rat thyroid morphology and expression of HSP-90

Misa-Agustiño MJ, Jorge-Mora T, Jorge-Barreiro FJ, Suarez-Quintanilla J, Moreno-Piquero E, Ares-Pena FJ, López-Martín E.Exposure to non-ionizing radiation provokes changes in rat thyroid morphology and expression of HSP-90. Exp Biol Med (Maywood). 2015 Feb 2.

Abstract

Non-ionizing radiation at 2.45 GHz may modify the morphology and expression of genes that codify heat shock proteins (HSP) in the thyroid gland. Diathermy is the therapeutic application of non-ionizing radiation to humans for its beneficial effects in rheumatological and musculo-skeletal pain processes.

We used a diathermy model on laboratory rats subjected to maximum exposure in the left front leg, in order to study the effects of radiation on the nearby thyroid tissue. Fifty-six rats were individually exposed once or repeatedly (10 times in two weeks) for 30 min to 2.45 GHz radiation in a commercial chamber at different non-thermal specific absorption rates (SARs), which were

calculated using the finite difference time domain technique. We used immunohistochemistry methods to study the expression of HSP-90 and morphological changes in thyroid gland tissues.

Ninety minutes after radiation with the highest SAR, the central and peripheral follicles presented increased size and the thickness of the peripheral septa had decreased. Twenty-four hours after radiation, only peripheral follicles radiated at 12 W were found to be smaller. Peripheral follicles increased in size with repeated exposure at 3 W power.

Morphological changes in the thyroid tissue may indicate a glandular response to acute or repeated stress from radiation in the hypothalamic-pituitary-thyroid axis. Further research is needed to determine if the effect of this physical agent over time may cause disease in the human thyroid gland.

http://1.usa.gov/1Fb1Ykz

Excerpts

The thyroid gland is one of the most superficial vital organs and possibly more vulnerable to EMFs.7 Chronic exposure to microwaves at a RF of 2.45 GHz has been shown to significantly affect the hypothalamus–pituitary–thyroid (HPT) axis, provoking changes in body temperature, behavior, and thyroid hormone concentrations.8 Alterations in human and animal levels of thyroid stimulating hormone and other thyroid hormones have also been reported with chronic exposure to frequencies used in mobile telephones, such as 900 MHz.
Heat shock protein (HSP) 90 is a chaperone protein regulating several client proteins involved in thyroid cancer development and the level of expression is higher than in normal tissues. This chaperone has emerged as an exciting target in the development of cancer chemotherapeutics.11,12 Recently, we discovered that repeated, acute subthermal radiation for 30 min at 2.45 GHz can alter cellular stress levels in rat hypothalamus13 and thyroid gland,14 without initially altering apoptotic capacity. Surprisingly, in spite of frequent direct and indirect exposure to non-ionizing radiation in human environments and indications that radiation provokes a degree of stress in thyroid cells, there is very little research describing morphological changes that point to precocious re-adjustments of the mammalian thyroid gland after close-range exposure to non-ionizing radiation at 2.45 GHz.

Group A: single exposure and studied after 90 min (n = 18): The rats were divided into three subgroups (n = 6); each rat was exposed to 30 mina of microwave radiation at three levels: 0 (control), 3, and 12 W.b The rats were kept alive for 90 minc and then euthanized and perfused with fixative.
Group B: single exposure and studied after 24 h (n = 18): The rats were divided into three subgroups (n = 6); each rat was exposed to 30 min of microwave radiation at three levels: 0 (control), 3, and 12 W.b The rats were kept alive for 24 hc and then euthanized and perfused with fixative.
Group C: repeated exposure and studied after 90 min (n = 20): Rats in this group were irradiated at 3 W for 30 min/day, for a total of 10 times in a two-week period. On the last day of exposure, the rats were irradiated and after 90 min were euthanized and perfused with fixative. They were then tested for HSP-90 expression. In the non-irradiated control group (n = 10), rats were immobilized for each of the 10 sessions and euthanized on the last day, following the same protocol as the irradiated animals.

... we found that the interaction of non-ionizing radiation at a frequency of 2.45 GHz caused modifications in the morphology of the thyroid gland tissue and in the distribution of the constituent cellular stress protein known as HSP-90. The morphology of the thyroid gland underwent the following changes due to radiation:

The size of central and peripheral follicles increased and the thickness of the peripheral septa decreased 90 min after single exposure. After 24 h, central follicles had decreased in size, but hypertrophy was still present in the peripheral follicles of thyroid gland exposed to the higher SAR level.

Repeated stimulus of the thyroid gland at the lower SAR level triggered adaptation and an increase in the size of peripheral follicles.
The observed localization of the expression of this protein in the supportive tissue of the septa, specifically in the fibers and in the capsular and lobular membranes suggests that this stress protein constitutes an important component of glandular architecture and is probably dedicated to maintaining glandular structure and morphology. The distribution of HSP-90 in thyroid membranes and cells was diminished after single (if the SAR and time after radiation increased) and repeated exposure to radiation.

Our work describes for the first time the effects of single and repeated exposure to 2.45 GHz RF on the morphology of Sprague-Dawley rat thyroid gland. Published studies to date have described histopathological alterations in thyroid tissue of experimental animals exposed to extremely low frequency (ELF) (50 Hz) or in thyroid hormone levels in humans or animals exposed at ELF or RF.
We chose to experimentally examine small animals at 2.45 GHz RF because of the wide range of potential applications, from therapeutics to tissue diathermy (this frequency resonates with H_2O, facilitating greater penetration) to telecommunications involving WIFI, UMTS, or Bluetooth. We used **subthermal SAR levels** of 0.102 ± 12.10^{-3} and 0.429 ± 12.10^{-3} W/kg at 2.45 GHz in the right front leg, near the thyroid, to ensure that the non-ionizing radiation would not cause direct thermal effects to the gland. Research of this type requires immobilization of the animal, which itself has been found to generate a certain amount of stress. It must also be noted that radiation can catalyze single or repetitive activation of different neuron populations in rat hypothalamus, which intervene in the HPT axis. We cannot therefore assume that the effects of non-ionizing radiation to the thyroid are limited to its tissues; it must be treated as part of a system with multiple, interacting entry points. Other studies have described how microwave radiation at 2.45 GHz affects brain physiopathology and provokes changes in cerebral functioning and behavior. In the present study, the thyroid system is directly or indirectly affected by alterations in the HPT axis as well as by biochemical changes in the thyroid itself due to exposure to microwaves.

Recent research has described how EMFs can constitute external sources for the formation of free radicals in blood cells, the brain, spermatozoids,and myocardial tissue. The thyroid gland is by nature an oxidative organ, and when additional oxidative abuse is caused by exogenous pro-oxidants (ionizing radiation would be the most significant), damage to the macromolecules in the gland increases, possibly leading to thyroid pathology or cancer. In spite of this, a direct relation between thyroid cancer and exposure to EMFs has not yet been established. However, the search is ongoing for biomarkers in thyroid diseases that would make early detection, diagnosis, and intervention possible. HSP-90 is physiologically essential in cellular processes such as hormone signaling and control, proliferation, and differentiation of the cellular cycle. In prior studies, we described a decrease in HSP-90 and 70 due to acute radiation at 2.45 GHz in the thyroid gland, with no apparent effect in the apoptotic activity of thyroid cells. HSP-90 is known to play a modulatory role against thyroid cancer due to its primarily antiapoptotic function. In the present work, we have observed how, after 30 min exposure, the immunoreactivity of HSP-90 is histologically distributed throughout the thyroid gland in places where kinase proteins had previously been activated, between the capsular and lobular membranes and in the follicular and parafollicular cells.

... cellular damage in the thyroid gland was directly related to the SAR level and/or number of exposures applied to the tissue.

... In the present experiment, exposure of rat thyroid gland to RF at 2.45 GHz and 0.102 ± 12.10^{-3} SAR increased HSP-90 marking in the parafollicular cells. However, HSP-90 stress immunomarking decreased in the parafollicular cells at 0.429 ± 12.10^{-3} SAR or with repeated exposure (see Figure 7). HSP-90 in the parafollicular cell is sensitive to the nature and intensity of radiation stimulus, which can modify cellular function and serve as a biomarker for cellular damage.

Thyroid gland exposed to 2.45 GHz radiation in this experimental model of diathermy in rats presented the following visible morphological effects: (a) glandular hypertrophy in relation to the SAR and/or number of exposures; (b) modification of the distribution of HSP-90 associated with membranes and parafollicular cells. These effects might not be exclusively or directly produced by radiation and can be included with other indirect effects from the hypothalamus. However, further research is needed to ascertain whether the continued effect of this physical agent could provoke pathology in the thyroid gland.

K, Sechman A, Nieckarz Z. Plasma thyroid hormones and corticosterone levels in blood of chicken embryos and post hatch chickens exposed during incubation to 1800 MHz electromagnetic field. Int J Occup Med Environ Health. 2014 Jan 31.

Abstract

INTRODUCTION: This study attempted to determine the effect of a 1800 MHz electromagnetic field (EMF) (only carrier frequency) on thyroxine (T4), triiodothyronine (T3) and corticosterone (CORT) concentrations in the blood plasma of chick embryos, and to investigate the effect of electromagnetic field (EMF) exposure during embryogenesis on the level of these hormones in birds that are ready for slaughter.

MATERIAL AND METHODS: Throughout the incubation period, embryos from the experimental group were exposed to a 1800 MHz EMF with power density of 0.1 W/m2, 10 times during 24 h for 4 min. Blood samples were collected to determine T4, T3 and CORT concentrations on the 12th (E12) and 18th (E18) day of incubation, from newly hatched chicks (D1) and from birds ready for slaughter (D42).

RESULTS: The experiment showed that T4 and T3 concentrations decreased markedly and CORT levels increased in the embryos and in the newly hatched chicks exposed to EMF during embryogenesis. However, no changes were found in the level of the analyzed hormones in the birds ready for slaughter. Differences in T4 and T3 plasma concentrations between the EMF-exposed group and the embryos incubated without additional EMF were the highest in the newly hatched chicks, which may be indicative of the cumulative effect of electromagnetic field on the hypothalamo-pituitary-thyroid axis (HPT).

DISCUSSION: The obtained results suggest that additional 1800 MHz radio frequency electromagnetic field inhibits function of HPT axis, however, it stimulates hypothalamo-pituitary-adrenal axis by inducing adrenal steroidogenic cells to synthesize corticosterone. Further investigations are needed to elucidate the mechanisms by which radio EMFs affect HPT and HPA axis function in the chicken embryos.

http://1.usa.gov/1e4do9w

Jin YB, Choi HD, Kim BC, Pack JK, Kim N, Lee YS.Effects of simultaneous combined exposure to CDMA and WCDMA electromagnetic fields on serum hormone levels in rats. J Radiat Res. 2013 May;54(3):430-7. doi: 10.1093/jrr/rrs120.

Abstract

Despite more than a decade of research on the endocrine system, there have been no published studies about the effects of concurrent exposure of radiofrequency electromagnetic fields (RF-EMF) on this system. The present study investigated the several parameters of the endocrine system including melatonin, thyroid stimulating hormone, stress hormone and sex hormone after code division multiple access (CDMA, 849 MHz) and wideband code division multiple access (WCDMA, 1.95 GHz) signals for simultaneous exposure in rats. Sprague-Dawley rats were exposed to RF-EMF signals for 45 min/day, 5 days/week for up to 8 weeks. The whole-body average specific absorption rate (SAR) of CDMA or WCDMA was 2.0 W/kg (total 4.0 W/kg). At 4 and 8 weeks after the experiment began, each experimental group's 40 rats (male 20, female 20) were autopsied. Exposure for 8 weeks to simultaneous CDMA and WCDMA RF did not affect serum levels in rats of melatonin, thyroid stimulating hormone (TSH), triiodothyronine (T3) and thyroxin (T4), adrenocorticotropic hormone (ACTH) and sex hormones (testosterone and estrogen) as assessed by the ELISA method.

http://www.ncbi.nlm.nih.gov/pubmed/23239176

Dimida A, Ferrarini E, Agretti P, De Marco G, Grasso L, Martinelli M, Longo I, Giulietti D, Ricci A, Galimberti M, Siervo B, Licitra G, Francia F, Pinchera A, Vitti P, Tonacchera M. Electric and magnetic fields do not modify the biochemical properties of FRTL-5 cells. J Endocrinol Invest. 2011 Mar;34(3):185-9. doi: 10.3275/7107.

Abstract

BACKGROUND: Electric and magnetic fields (EMF) might be involved in human disease and numerous research and scientific reviews have been conducted to address this question. In particular thyroid structural and functional alterations caused by various forms of non-ionizing radiation have been described.

AIM: The aim of this study was to analyze the possible effects of EMF on thyroid, in particular we analyzed the effects caused by a GSM (Global System for Mobile Communications) signal (900 MHz) on cultured thyroid cells (FRTL- 5).

MATERIAL AND METHODS: The experimental setup was designed in order to expose samples to a radiofrequency wave in well-controlled conditions. We used the FRTL-5 cell line, an epithelial monoclonal continuous cell line derived from Fisher rat thyroid tissue growing as monolayer, expressing the TSH receptor and the sodium-iodide symporter (NIS). FRTL-5 were subsequently irradiate for 24, 48, and 96 h with EMF (800-900 MHz, power-frequency of mobile communication systems) and iodide uptake and cAMP production were measured.

RESULTS: The irradiation of cells with EMF at 900 Mhz for 24, 48, and 96 h did not influence the level of cAMP production and was not able to modify iodide accumulation in FRTL- 5 cells with respect to basal conditions.

CONCLUSIONS: In conclusion, EMF do not seem to be able to interfere with the biochemical properties of FRTL-5 cells in vitro.

http://www.ncbi.nlm.nih.gov/pubmed/20543553

Esmekaya MA, Seyhan N, Ömeroglu S. Pulse modulated 900 MHz radiation induces hypothyroidism and apoptosis in thyroid cells: a light, electron microscopy and immunohistochemical study. Int J Radiat Biol. 2010 Dec;86(12):1106-16.

Abstract

PURPOSE: In the present study we investigated the possible histopathological effects of pulse modulated Radiofrequency (RF) fields on the thyroid gland using light microscopy, electron microscopy and immunohistochemical methods.

MATERIALS AND METHODS: Two months old male Wistar rats were exposed to a 900 MHz pulse-modulated RF radiation at a specific absorption rate (SAR) of 1.35 Watt/kg for 20 min/day for three weeks. The RF signals were pulse modulated by rectangular pulses with a repetition frequency of 217 Hz and a duty cycle of 1:8 (pulse width 0.576 ms). To assess thyroid endocrine disruption and estimate the degree of the pathology of the gland, we analysed structural alterations in follicular and colloidal diameters and areas, colloid content of the follicles, and height of the follicular epithelium. Apoptosis was confirmed by Transmission Electron Microscopy and assessing the activites of an initiator (caspase-9) and an effector (caspase-3) caspases that are important markers of cells undergoing apoptosis.

RESULTS: Morphological analyses revealed hypothyrophy of the gland in the 900 MHz RF exposure group. The results indicated that thyroid hormone secretion was inhibited by the RF radiation. In addition, we also observed formation of apoptotic bodies and increased caspase-3 and caspase-9 activities in thyroid cells of the rats that were exposed to modulated RF fields.

CONCLUSION: The overall findings indicated that whole body exposure to pulse-modulated RF radiation that is similar to that emitted by global system for mobile communications (GSM) mobile phones can cause pathological changes in the thyroid gland by altering the gland structure and enhancing caspase-dependent pathways of apoptosis.

http://www.ncbi.nlm.nih.gov/pubmed/20807179

Milham S. Most cancer in firefighters is due to radio-frequency radiation exposure not inhaled carcinogens. Med Hypotheses. 2009 Nov;73(5):788-9. doi: 10.1016/j.mehy.2009.04.020.

Abstract

Recent reviews and reports of cancer incidence and mortality in firefighters conclude that they are at an increased risk of a number of cancers. These include leukemia, multiple myeloma, non-Hodgkin's lymphoma, male breast cancer, malignant melanoma, and cancers of the brain, stomach, colon, rectum, prostate, urinary bladder, testes, and thyroid. Firefighters are exposed to a long list of recognized or probable carcinogens in combustion products and the presumed route of exposure to these carcinogens is by inhalation. Curiously, respiratory system cancers and diseases are usually not increased in firefighters as they are in workers exposed to known inhaled carcinogens. The list of cancers with increased risk in firefighters strongly overlaps the list of cancers at increased risk in workers exposed to electromagnetic fields (EMF) and radiofrequency radiation (RFR). Firefighters have increased exposure to RFR in the course of their work, from the mobile two-way radio communications devices which they routinely use while fighting fires, and at times from firehouse and fire vehicle radio transmitters. I suggest that some of the increased cancer risk in firefighters is caused by RFR exposure, and is therefore preventable. The precautionary principle should be applied to reduce the risk of cancer in firefighters, and workman's compensation rules will necessarily need to be modified.

http://www.ncbi.nlm.nih.gov/pubmed/19464814

Mortavazi S, Habib A, Ganj-Karami A, Samimi-Doost R, Pour-Abedi A, Babaie A. Alterations in TSH and Thyroid Hormones following Mobile Phone Use. Oman Med J. 2009 Oct;24(4):274-8. doi: 10.5001/omj.2009.56.

Abstract

OBJECTIVES: In recent years, the widespread use of mobile phones has lead to a public debate about possible detrimental effects on human health. In spite of years of research, there is still a great controversy regarding the possibility of induction of any significant physiological effects in humans by microwave radiations emitted by mobile phones. This study aims to investigate the effects of electromagnetic fields induced by the Global System for Mobile communications (GSM) mobile phones on the Thyroid Stimulating Hormone (TSH) and thyroid hormones in humans.

METHODS: 77 healthy university students participated in this study. The levels of T3, T4 and TSH were measured by using appropriate enzyme-linked immunosorbent assay (ELISA) kits (Human, Germany).

RESULTS: The average levels of T3, T4 and TSH in students who moderately used mobile phones were 1.25±0.27 ng/ml, 7.76±1.73 µg/dl and 4.25±2.12 µu/l respectively. The levels in the students who severely used mobile phones were 1.18±0.30, 7.75±1.14 and 3.75±2.05 respectively. In non-users, the levels were 1.15±0.27, 8.42±2.72 and 2.70±1.75, respectively. The difference among the levels of TSH in these 3 groups was statistically significant ($P<0.05$).

CONCLUSION: As far as the study is concerned, this is the first human study to assess the associations between mobile phone use and alterations in the levels of TSH and thyroid hormones. Based on the findings, a higher than normal TSH level, low mean T4 and normal T3 concentrations in mobile users were observed. It seems that minor degrees of thyroid dysfunction with a compensatory rise in TSH may occur following excessive use of mobile phones. It may be concluded that possible deleterious effects of mobile microwaves on hypothalamic-pituitary-thyroid axis affects the levels of these hormones.

http://www.ncbi.nlm.nih.gov/pubmed/22216380

Djeridane Y, Touitou Y, de Seze R. Influence of electromagnetic fields emitted by GSM-900 cellular telephones on the circadian patterns of gonadal, adrenal and pituitary hormones in men. Radiat Res. 2008 Mar;169(3):337-43.

Abstract

The potential health risks of radiofrequency electromagnetic fields (RF EMFs) emitted by mobile phones are currently of considerable public interest. The present study investigated the effect of exposure to 900 MHz GSM radiofrequency radiation on steroid (cortisol and testosterone) and pituitary (thyroid-stimulating hormone, growth hormone, prolactin and adrenocorticotropin) hormone levels in 20 healthy male volunteers. Each subject was exposed to RF EMFs through the use of a cellular phone for 2 h/day, 5 days/ week, for 4 weeks. Blood samples were collected hourly during the night and every 3 h during the day. Four sampling sessions were performed at 15-day intervals: before the beginning of the exposure period, at the middle and the end of the exposure period, and 15 days later. Parameters evaluated included the maximum serum concentration, the time of this maximum, and the area under the curve for hormone circadian patterns. Each individual's pre-exposure hormone concentration was used as his control. All hormone concentrations remained within normal physiological ranges. The circadian profiles of prolactin, thyroid-stimulating hormone, adrenocorticotropin and testosterone were not disrupted by RF EMFs emitted by mobile phones. For growth hormone and cortisol, there were significant decreases of about 28% and 12%, respectively, in the maximum levels when comparing the 2-week (for growth hormone and cortisol) and 4-week (for growth hormone) exposure periods to the pre-exposure period, but no difference persisted in the postexposure period. Our data show that the 900 MHz EMF exposure, at least under our experimental conditions, does not appear to affect endocrine functions in men.

http://www.ncbi.nlm.nih.gov/pubmed/18302481

Koyu A, Cesur G, Ozguner F, Akdogan M, Mollaoglu H, Ozen S. Effects of 900 MHz electromagnetic field on TSH and thyroid hormones in rats. Toxicol Lett. 2005 Jul 4;157(3):257-62.

Abstract

In this study, the effects of exposure to a 900 megahertz (MHz) electromagnetic field (EMF) on serum thyroid stimulating hormone (TSH) and triiodothronine-thyroxin (T3-T4) hormones levels of adult male Sprague-Dawley rats were studied. Thirty rats were used in three independent groups, 10 of which were control (without stress and EMF), 10 of which were exposed to 900 MHz EMF and 10 of which were sham-exposed. The exposures were performed 30 min/day, for 5 days/week for 4 weeks to 900 MHz EMF. Sham-exposed animals were kept under the same environmental conditions as the study groups except with no EMF exposure. The concentration of TSH and T3-T4 hormones in the rat serum was measured by using an immunoradiometric assay (IRMA) method for TSH and a radio-immunoassay (RIA) method for T3 and T4 hormones. TSH values and T3-T4 at the 900 MHz EMF group were significantly lower than the sham-exposed group ($p<0.01$). There were no statistically significant differences in serum TSH values and T3-T4 hormone concentrations between the control and the sham-exposed group ($p>0.05$). These results indicate that 900 MHz EMF emitted by cellular telephones decrease serum TSH and T3-T4 levels.

http://www.ncbi.nlm.nih.gov/pubmed/15917150

Wakeford R. The cancer epidemiology of radiation. Oncogene. 2004 Aug 23;23(38):6404-28.

Abstract

Ionizing radiation has been the subject of intense epidemiological investigation. Studies have demonstrated that exposure to moderate-to-high levels can cause most forms of cancer, leukaemia and cancers of the breast, lung and thyroid being particularly sensitive to induction by radiation, especially at young ages at exposure. Predominant among these studies is the Life Span Study of the cohort of survivors of the atomic bombings of Japan in 1945, but substantial evidence is derived from groups exposed for medical reasons, occupationally or environmentally. Notable among these other groups are underground hard rock miners who inhaled radioactive radon gas and its decay products, large numbers of patients irradiated therapeutically and workers who received high doses in the nuclear weapons programme of the former USSR. The degree of carcinogenic risk arising from low levels of exposure is more contentious, but the available evidence points to an increased risk that is approximately proportional to the dose received. Epidemiological investigations of nonionizing radiation have established ultraviolet radiation as a cause of skin cancer. However, the evidence for a carcinogenic effect of other forms of nonionizing radiation, such as those associated with mobile telephones or electricity transmission lines, is not convincing, although the possibility of a link between childhood leukaemia and extremely low-frequency electromagnetic fields cannot be dismissed entirely.

http://www.ncbi.nlm.nih.gov/pubmed/15322514

Bergamaschi A, Magrini A, Ales G, Coppeta L, Somma G. Are thyroid dysfunctions related to stress or microwave exposure (900 MHz)? Int J Immunopathol Pharmacol. 2004 May-Aug;17(2 Suppl):31-6.

Abstract

In the last decade, numerous scientific evidence suggested possible adverse health effects from exposure to electromagnetic fields (EMF'S) and the use of mobile phones. According to some studies EMF induced changes of trans-membrane Ca++ flux may lead to altered metabolism and/or secretion of neurohormones including TSH, ACTH, GH, prolactin and melatonin. The aim of this research was to analyse the effects of mobile phone use on thyroid function and to evaluate the possible role of occupational stress. 2598 employees (1355 men and 1243 women) with different duties (vendors, operators and network technicians) were included in the study. Exposure to EMF'S, generated by mobile phones, was assessed both by submitting a questionnaire directly to the employees and acquiring data regarding conversation times. The workers were divided into three groups on the basis of their personal mobile phone use. Moreover, a group of 160 workers with TSH values below 0.4 UI/l was characterized. No statistically significant difference regarding TSH values below 0.4 UI/l was observed among workers with different duties but there was a greater prevalence of subjects with low SH values among 192 employees with more than 33 hrs./month conversation time; this difference was statistically significant ($p<0.05$). On the basis of our data, it is not possible to establish whether this result is determined by exposure to EMF'S from mobile phones of by the stress of using these instruments.

http://www.ncbi.nlm.nih.gov/pubmed/15345189

Black DR, Heynick LN. Radiofrequency (RF) effects on blood cells, cardiac, endocrine, and immunological functions. Bioelectromagnetics. 2003;Suppl 6:S187-95.

Abstract

Effects of radiofrequency electromagnetic fields (RFEMF) on the pituitary adrenocortical (ACTH), growth (GH), and thyroid (TSH) hormones have been extensively studied, and there is coherent research on reproductive hormones (FSH and LH). Those effects which have been identified are clearly caused by heating. The exposure thresholds for these effects in living mammals, including primates, have been established. There is limited evidence that indicates no interaction between RFEMF and the pineal gland or an effect on prolactin from the pituitary gland. Studies of RFEMF exposed blood cells have shown that changes or damage do not occur unless the cells are heated. White cells (leukocytes) are much more sensitive than red cells (erythrocytes) but white cell effects remain consistent with normal physiological responses to systemic temperature fluctuation. Lifetime studies of RFEMF exposed animals show no cumulative adverse effects in their endocrine, hematological, or immune systems. Cardiovascular tissue is not directly affected adversely in the absence of significant RFEMF heating or electric currents. The regulation of blood pressure is not influenced by ultra high frequency (UHF) RFEMF at levels commonly encountered in the use of mobile communication devices.

http://www.ncbi.nlm.nih.gov/pubmed/14628314

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure f
cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Thursday, October 5, 2017

Brain Tumor Rates Are Rising in the US: The Role of Cell Phone & Cordless Phone Use

For additional evidence that cellphone and cordless phone use increase brain tumor risk and that brain tumor incidence has been increasing in the U.S. see **"Should Cellphones Have Warning Labels?" and**

STORYLINE vs. REST-OF-THE-STORY:

Brain cancer incidence, cellphone use, and trends data

Hardell and Carlberg (2015) reported that brain tumor rates have been increasing in Sweden based upon the Swedish National Inpatient Registry data. Hardell and Carlberg (2017) reported that brain tumors of unknown type increased from 2007-2015, especially in the age group 20-39 years of age. According to the authors, "This may be explained by higher risk for brain tumor in subjects with first use of a wireless phone before the age of 20 years taking a reasonable latency period."

What about brain tumor rates in the United States?

The incidence of **glioma, the most common malignant brain tumor,** has been increasing in recent years in the United States, although not across-the-board. The National Cancer Institute reported that glioma incidence in the frontal lobe increased among young adults 20-29 years of age (Inskip et al., 2010).

The incidence of glioblastoma multiforme (GBM), which accounts for about half of all gliomas, increased in the frontal and temporal lobes, and in the cerebellum among adults in the U.S. from 1992-2006 (Zada et al., 2012).

The Cancer Prevention Institute of California (2016) in their annual report about cancer incidence in the greater San Francisco Bay Area noted that the incidence of GBM increased from 1988-2013 among non-Hispanic white male (0.7% per year) and female adults (1.1% per year) and remained stable among other race/ethnic groups.

Using national tumor registry data, a recent study found that the overall incidence of **meningioma, the most common non-malignant brain tumor**, has increased in the United States in recent years (Dolecek et al., 2015). The age-adjusted incidence rate for meningioma increased from about 6.3 per 100,000 in 2004 to about 7.8 per 100,000 in 2009. Brain tumor incidence increased for all age groups except youth (0-19 years of age).

Risk of glioma from cell phone and cordless phone use

Three independent, case-control studies have found that long-term use of cell phones increases risk for glioma (Interphone Study Group, 2010; Hardell et al. 2013; Coureau et al. 2014). The only research to examine cordless phone use also found increased glioma risk with long-term use (Hardell et al, 2013). These studies include data from 13 nations: Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden and the UK. After ten years of wireless phone use (i.e., cell phone plus cordless phone use), the risk of glioma doubles and after 25 years, the risk triples (Hardell et al, 2013).

Although the U.S. does not conduct research on wireless phone use and tumor risk in humans and does not participate in the international studies, there is no reason to believe that Americans are immune to these potential effects of wireless phone use.

In sum, the peer-reviewed research on brain tumor risk and wireless phone use strongly suggests that we should exercise precaution and keep cell phones and cordless phones away from our heads. Moreover, the research calls into question the adequacy of national and international guidelines that limit the amount of microwave radiation emitted by cell phones and cordless phones.

Risk of meningioma from cell phone and cordless phone use

A study by Carlberg and Hardell (2015) adds to the growing body of evidence that heavy use of wireless phones (i.e., cell phones and cordless phones) is associated with increased risk of meningioma in Sweden. Heavy cordless phone users (defined as more than 1,436 hours of lifetime use) had a 1.7-fold greater risk of meningioma (OR = 1.7; 95% CI = 1.3-2.2). The heaviest cordless phone users (defined as more than 3,358 hours of lifetime use) had a two-fold greater risk of meningioma (OR = 2.0; 95% CI = 1.4 - 2.8). The heaviest cell phone users had a 1.5-fold greater risk of meningioma (OR = 1.5, 95% CI = 0.99 - 2.1).

Two earlier case-control studies conducted in other nations have found significant evidence of increased risk for meningioma among heavy cell phone users:

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Electromagnetic Radiation Safety

- Overview of Contents
- Welcome to EMR Safety
- Cell phone cancer risk: Spin vs. Fact
- Tips to Reduce Your Wireless Radiation Exposure
- Latest News

Archive

- 2018 (9)
- 2017 (39)
  - December (8)
  - November (5)
  - October (7)
    - Scientists and Doctors Demand Moratorium on 5
    - 5G Wireless Technology: Major newspaper edito
    - iPhone 8 Models: Specific Absorption Rates (SAF
    - Key Cell Phone Radiation Research Studies
    - Brain Tumor Rates Are Rising in the US: The Rol
    - Quotes from 21 Experts Regarding Electromagne
    - International Scientist Appeal on Electromagneti
  - September (6)
  - August (2)
  - June (1)
  - May (2)
  - April (3)
  - March (2)
  - February (1)
  - January (2)
- 2016 (32)
- 2015 (32)
- 2014 (11)
- 2013 (41)

(1) In France, Coureau et al (2014) found a two and a half-fold greater risk of meningioma for heavy cell phone users (defined as 896 or more hours of lifetime use) (OR = 2.57; 95% CI = 1.02 to 6.44).

(2) In Australia, Canada, France, Israel and New Zealand, Cardis et al. (2011) found a two-fold greater risk of meningioma for heavy cell phone users (defined as 3,124 or more hours of lifetime use) (OR = 2.01; 95% CI = 1.03 to 2.93).

The two prior studies did not assess cordless phone use so it's likely they underestimate the meningioma risk from cell phone use.

Thus, we now have three independent, case-control studies which find that wireless phone use is a risk factor for meningioma.

Recent Research Studies & Reports

Comparative Study of Brain & Central Nervous System Tumor Incidence between the U.S. and Taiwan

Chien LN, Gittleman H, Ostrom QT, Hung KS, Sloan AE, Hsieh YC, Kruchko C, Rogers LR, Wang YF, Chiou HY, Barnholtz-Sloan JS. Comparative Brain and Central Nervous System Tumor Incidence and Survival between the United States and Taiwan Based on Population-Based Registry. Front Public Health. 2016 Jul 21;4:151.

Abstract

PURPOSE: Reasons for worldwide variability in the burden of primary malignant brain and central nervous system (CNS) tumors remain unclear. This study compares the incidence and survival of malignant brain and CNS tumors by selected histologic types between the United States (US) and Taiwan.

METHODS: Data from 2002 to 2010 were selected from two population-based cancer registries for primary malignant brain and CNS tumors: theCentral Brain Tumor Registry of the United States and the Taiwan Cancer Registry. Two registries had similar process of collecting patients with malignant brain tumor, and the quality of two registries was comparative. The age-adjusted incidence rate (IR), IR ratio, and survival by histological types, age, and gender were used to study regional differences.

RESULTS: The overall age-adjusted IRs were 5.91 per 100,000 in the US and 2.68 per 100,000 in Taiwan. The most common histologic type for both countries was glioblastoma (GBM) with a 12.9% higher proportion in the US than in Taiwan. GBM had the lowest survival rate of any histology in both countries (US 1-year survival rate = 37.5%; Taiwan 1-year survival rate = 50.3%). The second largest group was astrocytoma, excluding GBM and anaplastic astrocytoma, with the distribution being slightly higher in Taiwan than in the US.

CONCLUSION: Our findings revealed differences by histological type and grade of primary malignant brain and CNS tumors between two sites.

Open Access Paper: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4954825/

Excerpts

Between 2002 and 2010, there were 183,740 newly diagnosed cases of malignant brain and CNS tumors in the US and 5,855 in Taiwan.

The most common histologic group for both countries was GBM; 47.8% of all tumors in the US and 34.9% of all tumors in Taiwan (Figure 3)

The IR of GBM was 2.9 times in the US (2.48 per 100,000) as compared with Taiwan (0.85 per 100,000). The second highest histologic group was astrocytoma (excluding GBM and AA) in both the US (0.95 per 100,000) and Taiwan (0.44 per 100,000).

In the US, the IRs by primary site were highest for tumors located in the frontal lobe (1.34 per 100,000), followed by tumors located in all other sites within the brain, temporal lobe, parietal lobe, and the other parts of brain and CNS. In Taiwan, the IRs were highest for tumors located in all other parts of the brain (0.70 per 100,000), followed by tumors located in the frontal lobe, temporal lobe, and cerebrum.

In this study, the lower age-adjusted IRs of malignant brain and CNS tumors in Taiwan was less likely due to differences in imaging diagnostic techniques as the standards for imaging for brain and CNS tumors was the same in both countries.

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Adolescent and Young Adult Primary Brain and Central Nervous System Tumors Diagnosed in the United States in 2008-2012

Ostrom QT, Gittleman H, de Blank PM, Finlay JL, Gurney JG, McKean-Cowdin R, Stearns DS, Wolff JE, Liu M, Wolinsky Y, Kruchko C, Barnholtz-Sloan JS. American Brain Tumor Association Adolescent and Young Adult Primary Brain and Central Nervous System Tumors Diagnosed in the United States in 2008-2012. Neuro Oncol. 2016 Jan;18 Suppl 1:i1-i50. http://www.ncbi.nlm.nih.gov/pubmed/26705298

The incidence of the most common non-malignant tumors (e.g., meningioma, pituitary) has increased in recent years among adolescents and young adults (AYA) in the U.S; however, some of this increase may be due to better reporting over time.

"Collection of data on non-malignant brain and CNS tumors began in 2004, after the passage of the Benign Brain Tumor Act in 2002. Previous analyses have suggested that increased incidence in the time period between 2004 and 2006 may be the result of the initiation of this collection rather than a 'true' increase in incidence."

- "Incidence of oligodendroglioma (APC = 22.9) and anaplastic oligodendroglioma (APC = 24.1) in AYA has significantly decreased from 2004-2012.
- Incidence of tumors of the meninges in AYA has significantly increased from 2004-2012 (APC = 2.5), which is largely driven by the increase of meningioma incidence during that time (APC = 2.6).
- Incidence of lymphomas and hematopoietic neoplasms has significantly decreased from 2004-2012 (APC = 22.8) in AYA.
- Incidence of tumors of the sellar region in AYA has significantly increased from 2004-2008 (APC = 8.5), which is largely driven by the increase of tumors of the pituitary incidence from 2004-2009 (APC = 7.6).
- Incidence of unclassified tumors in AYA has significantly increased from 2004-2012 (APC = 5.5), which is largely driven by the increase of hemangioma incidence from 2004-2010 (APC = 18.8)."

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Malignant Brain Tumors Most Common Cause of Cancer Deaths in Adolescents & Young Adults

Press Release, American Brain Tumor Association, Feb 24, 2016

A new report published in the journal *Neuro-Oncology* and funded by the American Brain Tumor Association (ABTA) finds that malignant brain tumors are the most common cause of cancer-related deaths in adolescents and young adults aged 15-39 and the most common cancer occurring among 15-19 year olds.

The 50-page report, which utilized data from the Central Brain Tumor Registry of the United States (CBTRUS) from 2008-2012, is the first in-depth statistical analysis of brain and central nervous system (CNS) tumors in adolescents and young adults (AYA). Statistics are provided on tumor type, tumor location and age group (15-19, 20-24, 25-29, 30-34 and 35-39) for both malignant and non-malignant brain and CNS tumors.

"When analyzing data in 5-year age increments, researchers discovered that the adolescent and young adult population is not one group but rather several distinct groups that are impacted by very different tumor types as they move into adulthood," said Elizabeth Wilson, president and CEO of the American Brain Tumor Association.

"For these individuals -- who are finishing school, pursuing their careers and starting and raising young families -- a brain tumor diagnosis is especially cruel and disruptive," added Wilson. "This report enables us for the first time to zero-in on the types of tumors occurring at key intervals over a 25-year time span to help guide critical research investments and strategies for living with a brain tumor that reflect the patient's unique needs."

Although brain and CNS tumors are the most common type of cancer among people aged 15-19, the report shows how other cancers become more common with age. By ages 34-39 years, brain and CNS tumors are the third most common cancer after breast and thyroid cancer.

"What's interesting is the wide variability in the types of brain tumors diagnosed within this age group which paints a much different picture than what we see in adults or in pediatric patients," explained the study's senior author Jill Barnholtz-Sloan, Ph.D., associate professor, Case Comprehensive Cancer Center, Case Western Reserve University School of Medicine and Scientific Principal Investigator for CBTRUS.

"For example, the most common tumor types observed in adults are meningiomas and glioblastomas, but there is much more diversity in the common tumor types observed in the adolescent and young adult population. You also clearly see a transition from predominantly non-malignant and low-grade tumors to predominantly high-grade tumors with increasing age," Barnholtz-Sloan said.

There are nearly 700,000 people in the U.S. living with brain and CNS tumors and approximately 15 percent of these tumors occurred in the AYA population during the 2008-2012 time frame analyzed in this report. Approximately 10,617 brain and CNS tumors are diagnosed among adolescents and young adults each year and are the cause of approximately 434 deaths annually.

"The American Brain Tumor Association's recognition of this understudied population, and their commitment to data and information sharing should be applauded," added Barnholtz-Sloan. "There are clearly unique characteristics of the 15-39 age group that we need to more comprehensively understand and the information in the ABTA report starts that important dialogue."

The full report is available at http://www.abta.org/about-us/news/brain-tumor-statistics/

To learn more or access additional statistics, go to http://www.abta.org.

http://bit.ly/1OvDHYy

Brain Tumor Statistics

Brain tumors are the:

- most common cancer among those age 0-19 (leukemia is the second)
- second leading cause of cancer-related deaths in children (males and females) under age 20 (leukemia is the first).
- Nearly 78,000 new cases of primary brain tumors are expected to be diagnosed this year. This figure includes nearly 25,000 primary malignant and 53,000 non-malignant brain tumors.

- It is estimated that more than 4,600 children between the ages of 0-19 will be diagnosed with a primary brain tumor this year.
- There are nearly 700,000 people in the U.S. living with a primary brain and central nervous system tumor.
- This year, nearly 17,000 people will lose their battle with a primary malignant and central nervous system brain tumor.
- There are more than 100 histologically distinct types of primary brain and central nervous system tumors.
- Survival after diagnosis with a primary brain tumor varies significantly by age, histology, molecular markers and tumor behavior.
- The median age at diagnosis for all primary brain tumors is 59 years.

Tumor-Specific Statistics:

- Meningiomas represent 36.4% of all primary brain tumors, making them the most common primary brain tumor. There will be an estimated 24,880 new cases in 2016.
- Gliomas, a broad term which includes all tumors arising from the gluey or supportive tissue of the brain, represent 27% of all brain tumors and 80% of all malignant tumors.
- Glioblastomas represent 15.1% of all primary brain tumors, and 55.1% of all gliomas.
- Glioblastoma has the highest number of cases of all malignant tumors, with an estimated 12,120 new cases predicted in 2016.
- Astrocytomas, including glioblastoma, represent approximately 75% of all gliomas.
- Nerve sheath tumors (such as acoustic neuromas) represent about 8% of all primary brain tumors.
- Pituitary tumors represent 15.5% of all primary brain tumors. There will be an estimated 11,700 new cases of pituitary tumors in 2016.
- Lymphomas represent 2% of all primary brain tumors.
- Oligodendrogliomas represent nearly 2% of all primary brain tumors.
- Medulloblastomas/embryonal/primitive tumors represent 1% of all primary brain tumors.
- The majority of primary tumors (36.4%) are located within the meninges.

http://www.abta.org/about-us/news/brain-tumor-statistics/

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Central Brain Tumor Registry of the United States: 2015 Fact Sheet

One in 161 Americans (0.62%) will be diagnosed with brain or other central nervous system (CNS) cancer during their lifetime according to the Central Brain Tumor Registry of the United States.

The risk is greater for males (1 in 144 or 0.69%) than females (1 in 182 or 0.55%); About three out of four people (74%) who develop brain or CNS cancer will die from this disease.

The risk of being diagnosed with a non-malignant (i.e., non-cancerous) brain or CNS tumor is about twice as great (14.75 vs. 7.23 per 100,000 per year).

Excerpts

> The incidence rate of all primary malignant and non-malignant brain and CNS tumors is 21.97 cases per 100,000 for a total count of 356,858 incident tumors; (7.23 per 100,000 for malignant tumors for a total count of 117,023 incident tumors and 14.75 per 100,000 for non-malignant tumors for a total count of 239,835 incident tumors). The rate is higher in females (23.95 per 100,000 for a total count of 206,565 incident tumors) than in males (19.82 per 100,000 for a total count of 150,271 incident tumors).
>
> An estimated 77,670 new cases of primary malignant and non-malignant brain and CNS tumors are expected to be diagnosed in the United States in 2016. This includes an estimated 24,790 primary malignant and 52,880 non-malignant that are expected to be diagnosed in the US in 2016.
>
> **Pediatric Incidence (Ages 0-14 Years)**
> The incidence rate of childhood primary malignant and non-malignant brain and CNS tumors in the US is 5.37 cases per 100,000 for a total count of 16,366 incident tumors. The rate is higher in males (5.61 per 100,000) than females (5.11 per 100,000).
>
> An estimated 4,630 new cases of childhood primary malignant and non-malignant brain and CNS tumors are expected to be diagnosed in the US in 2016.
>
> **Pediatric & Adolescent Incidence (Ages 0-19 Years)**
> The incidence rate of childhood and adolescent primary malignant and non-malignant brain and CNS tumors in the US is 5.57 per 100,000 for a total count of 23,113 incident tumors. The rate is higher in males (5.60 per 100,000) than females (5.54 per 100,000).
>
> An estimated 4,620 new cases of primary malignant and non-malignant brain and CNS tumors are expected to be diagnosed in the US in 2015.
>
> **Adolescent & Young Adult (AYA) Incidence (Ages 15-39 Years)**
> The incidence rate of AYA primary malignant and non-malignant brain and CNS tumors is 10.47 cases per 100,000 for a total count of 53,083 incident tumors.1 The rate is higher for non-malignant tumors (6.17 per 100,000) than malignant tumors (3.26 per 100,000).
>
> An estimated 10,390 new cases of AYA primary malignant and non-malignant brain and CNS tumors are expected to be diagnosed in the US in 2016.
>
> **Mortality**
> The average annual mortality rate in the US between 2008 and 2012 was 4.31 per 100,000 with 71,831 deaths attributed to primary malignant brain and CNS tumors.

An estimated 16,616 deaths will be attributed to primary malignant brain and CNS tumors in the US in 2016

Lifetime Risk
From birth, a person in the US has a 0.62% chance of ever being diagnosed with a primary malignant brain/CNS tumor (excluding lymphomas, leukemias, tumors of pituitary and pineal glands, and olfactory tumors of the nasal cavity) and a 0.46% chance of dying from the primary malignant brain/CNS tumor.

For males in the US, the risk of developing a primary malignant brain/CNS tumor is 0.69%, and the risk of dying from a primary malignant brain/CNS tumor (excluding lymphomas, leukemias, tumors of pituitary and pineal glands, and olfactory tumors of the nasal cavity) is 0.51%.

For females in the US, the risk of developing a primary malignant brain/CNS tumor is 0.55%, and the risk of dying from a primary malignant brain/CNS tumor (excluding lymphomas, leukemias, tumors of pituitary and pineal glands, and olfactory tumors of the nasal cavity) is 0.41%.

Prevalence
The prevalence rate for all primary brain and CNS tumors was estimated to be 221.8 per 100,000 (61.9 per 100,000 for malignant; 177.3 per 100,000 for non-malignant) in 2010. It was estimated that more than 688,096 persons were living with a diagnosis of primary brain and central nervous system tumor in the United States in 2010 (malignant tumors: more than 138,054 persons; non-malignant tumors: more than 550,042 persons).

The prevalence rate for all pediatric (ages 0-19) primary brain and central nervous system tumors was estimated at 35.4 per 100,000 with more than 28,000 children estimated to be living with this diagnosis in the United States in 2004.

Note
Estimated numbers of incidence of malignant and non-malignant brain and CNS tumors and deaths due to these tumors were calculated for 2015 and 2016 using age-adjusted annual tumor incidence rates generated for 2000-2012 for non-malignant tumors by state, age, and histologic type.

http://bit.ly/cbtrus2015

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Brain Tumors in Children and Adolescents

According to a recent study, there has been a significant increase in the incidence of primary malignant brain and central nervous system (CNS) tumors in American children (0-14 years of age) between 2000-2010, with an annual percentage change (APC) of 0.6%. In adolescents (15-19 years old), there was a significant increase in the incidence of primary malignant brain and CNS tumors between 2000-2008, with an APC of 1.0%. Adolescents also experienced an increase in non-malignant brain and CNS tumors from 2004-2010, with an APC of 3.9%.

The four-nation CEFALO case-control study found a 36% increased risk of brain tumors among children and adolescents 7-19 years of age who used mobile phones at least once a week for six months. Since this risk estimate was not statistically significant (OR = 1.36; 95% CI = 0.92 to 2.02), the authors dismissed this overall finding. However, in a subsample of 556 youth for whom cell phone company records were available, there was a significant association between the time since first mobile phone subscription and brain tumor risk. Children who used cellphones for 2.8 or more years were twice as likely to have a brain tumor than those who never regularly used cellphones (OR = 2.15, 95% CI = 1.07 to 4.29).

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Trends in Incidence of Non-Malignant Head and Neck Tumors in the U.S.

The likelihood of developing a non-malignant brain tumor has increased in recent years in the U.S. According to newly-released data from the Centers for Disease Control and Prevention (CDC), the overall age-adjusted incidence (per 100,000 persons) of non-malignant brain tumors significantly increased from 2004 through 2012. The increase was observed among children 0-19 years of age (1.7 in 2004; 2.3 in 2012) and among adults 20 years and older (15.9 in 2004; 19.7 in 2012).

Almost 200 people per day in the U.S. were diagnosed with brain tumors in 2012 including 67,612 adults and 4,615 children. Among adults, 70% of these tumors were nonmalignant, and among children, 42% were nonmalignant.

The overall incidence of malignant tumors in the U.S. has been stable for children (3.4 in 2004; 3.3 in 2012) and has slightly decreased for adults (9.1 in 2004; 8.4 in 2012). However, lags in reporting to tumor registries are common in the U.S. so official statistics may underestimate the actual incidence of tumors for more recent years (see August 5, 2015 post below).

A peer-reviewed study reported a significant increase over time in the incidence of *specific types* of malignant brain tumors among adults in the U.S. (see May 7, 2015 post below).

The age-adjusted incidence of the most common non-malignant tumor, **meningioma**, significantly increased among adults from 2004 through 2012 (8.7 in 2004; 10.6 in 2012).

A recent study reported a significant increase in meningioma incidence for the period 2004 through 2009 (Doleceket al., 2015). Several case-control studies have found a significant association between risk of meningioma and wireless phone use (see May 7, 2015 post below).

The age-adjusted incidence of **pituitary gland tumors** significantly increased among children (0.4 in 2004; 0.6 in 2012) and among adults (3.4 in 2004; 4.7 in 2012).

A prospective study of 790,000 women in the United Kingdom reported that the risk pituitary gland tumors was more than twice as high among women who used a cell phone for less than five years as compared to never users (Bensonet al., 2013).

The web-based report, ***United States Cancer Statistics: 1999-2012 Incidence and Mortality Web-based Report*** (USCS) is available at www.cdc.gov/uscs. Although the report includes cancer cases diagnosed (incidence) from 1999 through 2012, brain tumor incidence data are available only since 2004. In 2012, cancer incidence information came from central cancer registries in 49 states, 6 metropolitan areas, and the District of Columbia, covering 99% of the U.S. population.

The Interactive Cancer Atlas (InCA), with exportable data, shows how rates differ by state and change over time. InCA is available at https://nccd.cdc.gov/DCPC_INCA/.

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Limitations of Cancer Registries

Cancer registries are developed to collect data on malignant tumors and often do not collect data on non-malignant (sometimes called benign) tumors. Since about half of primary brain tumors are non-malignant, these tumors are may not be monitored by public health surveillance systems (e.g., Canada).

The U.S has a Central Brain Tumor Registry (CBTRUS): "a resource for gathering and disseminating current epidemiologic data on all primary brain tumors, **benign and malignant**, for the purposes of accurately describing their incidence and survival patterns, evaluating diagnosis and treatment, facilitating etiologic studies, establishing awareness of the disease, and ultimately, for the prevention of all brain tumors." However, "CBTRUS makes no representations or warranties, and gives no other assurances or guarantees, express or implied, with respect to the accuracy or completeness of the data presented."

There is a good reason for the disclaimer on the CBTRUS home page. Tumor registries are useful in monitoring disease incidence only to the extent that all procedures are well implemented. Registries are highly dependent upon reporting agencies (e.g., hospitals) to do an accurate and complete job in reporting tumors to the registry.

Registry data typically suffer from various problems:

> "Users must be aware of diverse issues that influence collection and interpretation of cancer registry data, such as multiple cancer diagnoses, duplicate reports, reporting delays, misclassification of race/ethnicity, and pitfalls in estimations of cancer incidence rates." (Izqierdo, JN, Schoenbach, VJ. The potential and limitations of data from population-based state cancer registries. Am J Public Health. 2000;90:695-698. URL: http://1.usa.gov/1IHO8FM)
>
> Delays in reporting and late ascertainment are a reality and a known issue influencing registry completeness and, consequently, rate underestimations occur, especially for the most recent years.[22] CBTRUS also recognizes that the problem may be even more likely to occur in the reporting of non-malignant brain and CNS tumors, where reporting often comes from non-hospital based sources and mandated collection is relatively recent (2004). Ostrom et al. (2014). URL: http://1.usa.gov/1PTmpaD).

For a discussion of the factors that undermine the data quality and completeness of cancer registry coverage of diagnosed tumors see Bray et al (2015), Coebergh et al (2015), and Siesling et al (2015).

The shortcomings of cancer registries are not just hypothetical. For example, Hardell and Carlberg (2015) recently reported that brain cancer rates have been increasing in Sweden based upon the Swedish National Inpatient Registry but not according to the Swedish Cancer Registry. Based upon their results they "postulate(d) that a large part of brain tumours of unknown type are never reported to the Cancer Register ... We conclude that the Swedish Cancer Register is not reliable .. "

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Labels: brain tumor, cancer registry, case-control, cell phone, cordless, Hardell, meningioma, pooled analysis, Swedish, tumor registry, wireless phone use

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Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation

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Abstract

Go to:

Objective. Bradford Hill's viewpoints from 1965 on association or causation were used on glioma risk and use of mobile or cordless phones. *Methods.* All nine viewpoints were evaluated based on epidemiology and laboratory studies. *Results.* Strength: meta-analysis of case-control studies gave odds ratio (OR) = 1.90, 95% confidence interval (CI) = 1.31–2.76 with highest cumulative exposure. Consistency: the risk increased with latency, meta-analysis gave in the 10+ years' latency group OR = 1.62, 95% CI = 1.20–2.19. Specificity: increased risk for glioma was in the temporal lobe. Using meningioma cases as comparison group still increased the risk. Temporality: highest risk was in the 20+ years' latency group, OR = 2.01, 95% CI =1.41–2.88, for wireless phones. Biological gradient: cumulative use of wireless phones increased the risk. Plausibility: animal studies showed an increased incidence of glioma and malignant schwannoma in rats exposed to radiofrequency (RF) radiation. There is increased production of reactive oxygen species (ROS) from RF radiation. Coherence: there is a change in the natural history of glioma and increasing incidence. Experiment: antioxidants reduced ROS production from RF radiation. Analogy: there is an increased risk in subjects exposed to extremely low-frequency electromagnetic fields. *Conclusion.* RF radiation should be regarded as a human carcinogen causing glioma.

1. Introduction

Go to:

In Sir Austin Bradford Hill's classic epidemiology paper from 1965, "*The Environment and Disease: Association or Causation?,*" he warned not to overrate the value of statistical significance since it often leads people to "*grasp the shadow and loose the substance*" of what is in the data [1]. In the interpretation of epidemiological studies on cancer there may be no explanation about how the strength of a link between a cause and an effect can vary from a "*scientific suspicion of risk*" to a "*strong association*" through "*reasonably certainty*" and to "*causality*" which requires the strongest evidence. This continuum in strengths of evidence, which was illustrated in Bradford Hill's paper, written at the height of the tobacco and lung cancer controversy, is not always explained. This means that the media and the public may assume that "*not causal*" means "*no link,*" with mobile phone use and brain tumour risk as one example.

In the Interphone study on mobile phone use and brain tumours an increased risk for glioma was found among the heaviest mobile phone users [2]. In an editorial accompanying the Interphone results published in the International Journal of Epidemiology [3], the main conclusion of the results was described as "*both elegant and oracular... (which) tolerates diametrically opposite readings.*" They also pointed out several methodological reasons why the Interphone results were likely to have underestimated the risks, such as the short latency period since first exposures became widespread; less than 10% of the Interphone cases had more than 10 years of exposure. "*None of the today's established carcinogens, including tobacco, could have been firmly identified as increasing risk in the first 10 years or so since first exposure.*" The concluding sentences from the Interphone study were "*oracular*": "*Overall, no increase in risk of either glioma or meningioma was observed in association with use of mobile phones. There were suggestions of an increased risk of glioma, and much less so meningioma, at the highest exposure levels, for ipsilateral exposures and, for glioma, for tumours in the temporal lobe. However, biases and errors limit the strength of the conclusions we can draw from these analyses and prevent a causal interpretation.*" This allowed the media to report opposite conclusions.

Due to the widespread use of wireless phones (mobile and cordless phones) an evaluation of the scientific evidence on the brain tumour risk was necessary. Thus, in May 2011 the International Agency for Research on Cancer (IARC) at WHO evaluated at that time published studies. The scientific panel reached the conclusion that radiofrequency (RF) radiation from mobile phones, and from other devices, including cordless phones, that emit similar nonionizing electromagnetic field (EMF) radiation in the frequency range 30 kHz–300 GHz, is a Group 2B, that is, a "possible," human carcinogen [4, 5]. The IARC decision on mobile phones was based mainly on case-control human studies by the Hardell group from Sweden [6–13] and the IARC Interphone study [2, 14, 15]. These studies provided supportive evidence of increased risk for brain tumours, that is, glioma and acoustic neuroma.

No doubt the IARC decision started a worldwide spinning machine to question the evaluation, perhaps similar to the one launched by the tobacco industry when IARC was studying and evaluating passive smoking as a carcinogen in the 1990s [16]. Sowing confusion and manufacturing doubt is a well-known strategy used by the tobacco and other industries [17–19]; see also Walker [20].

A fact sheet from WHO issued in June 2011 shortly after the IARC decision in May 2011 stated that "*to date, no adverse health effects have been established as being caused by mobile phone use*" [21]. This statement contradicted the IARC evaluation and was not based on evidence at that time on a carcinogenic effect from RF radiation and was certainly remarkable since IARC is part of WHO. Furthermore WHO wrote that "*currently, two international bodies have developed exposure guidelines for workers and for the general public, except patients undergoing medical diagnosis or treatment. These guidelines are based on a detailed assessment of the available scientific evidence.*" These organizations were the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE).

ICNIRP is a private organization (NGO) based in Germany that selects its own members. Their source of funding is not declared. IEEE is the world's most powerful federation of engineers. The members are or have been employed in companies or organizations that are producers or users of technologies that depend on radiation frequencies, such as power companies, the telecom industry, and military organizations. IEEE has prioritized international lobbying efforts for decades especially aimed at the WHO.

The IARC conclusion was soon also questioned by, for example, some members of ICNIRP [22]. The article by Swerdlow et al. appeared online 1 July 2011, one month after the IARC decision, and concluded that "*the trend in the accumulating evidence is increasingly against the hypotheses that mobile phone use can cause brain tumours in adults.*"

Soon after that other persons affiliated with ICNIRP, Repacholi and associates, made a review on wireless phone use and cancer risks. The paper appeared online October 21, 2011 [23], with similar conclusions as the Swerdlow et al. paper [22].

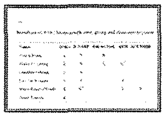
The exposure guideline by ICNIRP was established in 1998 [24] and was based only on thermal (heating) effects from RF-EMF neglecting nonthermal biological effects. It was updated in 2009 [25] and stated that "*it is the opinion of ICNIRP that the scientific literature published since the 1998 guidelines has provided no evidence of any adverse effects below the basic restrictions and does not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields. ...Therefore, ICNIRP reconfirms the 1998 basic restrictions in the frequency range 100 kHz–300 GHz until further notice.*" The guideline still provided by ICNIRP for RF radiation is 2 to 10 W/m^2 depending on frequency. It should be noted that the ICNIRP guideline is used in most European countries as well as in many other countries. Unfortunately it is based on old data with no acknowledgment of cancer effects or nonthermal biological effects from RF-EMF exposure.

There are a vast number of scientific articles that show nonthermal adverse health effects from RF radiation. These, as well as thermal effects, have been evaluated in several reports. In contrast to ICNIRP the BioInitiative Reports from 2007 [26], updated in 2012 [27], based the evaluation of health hazards also on nonthermal health effects from RF radiation. The BioInitiative 2012 Report, with updated references, defined the scientific benchmark for possible health risks as 30 to 60 $\mu W/m^2$. Considering also chronic exposure and sensitivity among children the precautionary target level was proposed to one-tenth of this, 3–6 $\mu W/m^2$ [27].

The guideline in the BioInitiative Report obviously contradicts the one proposed by ICNIRP. The ICNIRP exposure level has been vigorously propagated by that organization in order to harmonize guidelines worldwide. With few exceptions it has been a successful story and most countries have adopted the ICNIRP guideline. This gives a "green card" to roll out the technology with increasing RF radiation exposure to the population, for example, using wireless Internet access in schools [28], since the high exposure level in the guideline by ICNIRP is rarely compromised. Thus, the exposure target level in the BioInitiative Report is not acknowledged by, for example, the Swedish Radiation Safety Authority (SSM). Many persons at the SSM expert panel are also members of ICNIRP which might be a conflict of interests since they would rarely compromise the ICNIRP view; critical opinions are not heard. As a matter of fact the Ethical Board at the Karolinska Institute in Stockholm, Sweden, concluded already in 2008 that being a member of ICNIRP may be a conflict of interests that should be stated in scientific publications (Karolinska Institute Diary Number 3753-2008-609), which is however not done to our knowledge.

An association between use of wireless phones and glioma has not been acknowledged by several scientific bodies in spite of the IARC classification in May 2011. This is exemplified below. In fact, as can be seen in Table 1 the same persons may appear in different expert groups. This would hardly make any substantial difference in the opinion between these groups. They may in fact cite themselves by claiming that various organizations have come to similar conclusion. It is striking how ICNIRP has infiltrated the WHO Monograph core group making it less likely that the conclusions in that Monograph will differ from ICNIRP's conclusions.

Table 1



Members of WHO Monograph core group and their involvement in groups.

ICNIRP (2011). See conclusions at page 1537 [22].

> *The limited duration of data yet available, which is mainly for up to 10 years of exposure and to a lesser extent for a few years beyond this, also leave uncertainty because of the potential for long lag period effects, especially for meningioma which is generally slower growing than glioma. The possibility of a small or a longer term effect thus cannot be ruled out. Nevertheless, while one cannot be certain, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use causes brain tumours.*

AGNIR; Health Protection Agency (2012). See conclusions at page 312 [29].

> *In conclusion, despite methodological shortcomings, the available data do not suggest a causal association between mobile phone use and fast growing tumours such as malignant glioma in adults.*

Exposure from Mobile Phones, Base Stations, and Wireless Networks: A Statement by the Nordic Radiation Safety Authorities (2013). See page 1 [30].

> *The overall data published in the scientific literature to date do not show adverse health effects from exposure of radiofrequency electromagnetic fields below the guidelines or limits adopted in the Nordic countries...Since 2011, a number of epidemiological studies on mobile phone use and risk of brain tumours and other tumours of the head have been published. The overall data on brain tumour and mobile phone use do not show an effect on tumour risk.*

Health Canada (2015) [31].

> *Myth: The International Agency for Research on Cancer (IARC) classified radiofrequency energy as potentially carcinogenic. This means that I will get cancer due to my exposure to RF energy.*
>
> *Fact: The IARC did not find a direct link between RF energy exposure and cancer.*
>
> *In 2011, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization, 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. However, the vast majority of research to date does not support a link between RF energy exposure and cancers in humans.*

IET: The Institution of Engineering and Technology, UK (2014; Updated 2016). See page 2 [32].

> *BEPAG has concluded in this report that the balance of scientific evidence to date does not indicate that harmful effects occur in humans due to low-level exposure to EMFs. Our examination of the peer-reviewed literature published in the last two years has not justified a change in the overall conclusions published in our previous report in May 2014.*

SCENIHR: Scientific Committee on Emerging and Newly Identified Health Risks (2015). See page 84 [33].

Overall, the epidemiological studies on RF EMF exposure do not indicate an increased risk of brain tumours, and do not indicate an increased risk for other cancers of the head and neck region, or other malignant diseases including childhood cancer.

And looking further down at the same page, we find the following.

A working group at the International Agency for Research on Cancer (IARC) within the Monograph programme on the evaluation of carcinogenic risks to humans classified the epidemiological evidence for glioma and acoustic neuroma as limited and therefore evaluated RF fields as a possible human carcinogen (IARC, 2013). Based on studies published since that assessment (update of the Danish cohort study, the UK cohort study, further case-control studies, the case-control study on mobile phones and brain tumours in children and adolescents, the consistency checks of brain tumour incidence rates using data from the Nordic countries and the US), the evidence for glioma has become weaker.

SSM: Swedish Radiation Safety Authority (2015). See page 6 [34].

However, in previous reports the Scientific Council of SSM has concluded that studies of brain tumours and other tumours of the head (vestibular schwannoma, salivary gland), together with national cancer incidence statistics from different countries, are not convincing in linking mobile phone use to the occurrence of glioma or other tumours of the head region among adults. Recent studies described in this report do not change this conclusion although these have covered longer exposure periods. Scientific uncertainty remains for regular mobile phone use for time periods longer than 15 years.

Health Council of the Netherlands Mobile Phones and Cancer, Part 3. Update and Overall Conclusions from Epidemiological and Animal Studies (2016). See page 54 [35].

The available data do not allow drawing conclusions on whether there is an association between an increased carcinogenic risk and any form of accumulation of exposure, for instance expressed in the total call time, or the total amount of energy deposited by the electromagnetic fields generated by the phone in the head or in any other body part.... However, it is possible that some individuals would like to reduce their exposure, despite the conclusion of the Committee that there is no consistent evidence for an increased risk for tumours in the brain and other regions in the head associated with mobile phone use.

SSM: Swedish Radiation Safety Authority (2016). See page 91 [36].

Regarding mobile phone use and brain tumour risk, little new data was published and several papers deal with reanalyses of already published data. As a consequence, little has changed in the rating of the evidence.

It should be noted that SSM has never acknowledged an increased risk for brain tumours associated with use of wireless phones.

We published in 2013 an article on using the Bradford Hill viewpoints for brain tumour risk and use of wireless phones [37]. We concluded that based on these aspects "*glioma and acoustic neuroma should* *be considered to be caused by RF-EMF emissions from wireless phones and regarded as carcinogenic to humans."* Since then the scientific literature in this area has expanded considerably. Furthermore, as exemplified above, after the IARC evaluation in May 2011, several committees have evaluated the evidence on health risks associated with use of mobile phones. It should also be noted that these reports are not published in the peer-reviewed scientific literature and few physicians if at all are members of these groups. There seems also to be conflict of interests among these members. It is thus pertinent to make a new scientific evaluation using the Bradford Hill viewpoints including the most recent publications.

2. Methods

Go to:

Sir Austin Bradford Hill used nine viewpoints in his President's Address on circumstances that may "*pass from observed association to a verdict of causation"* [1]. Our research group has for long time studied RF radiation and health risks. This has included continuous surveillance of data bases on new studies, especially PubMed, but also personal communications with updated references from other researchers in this area. This article is partly based on our previous publication [37] and a presentation at the Royal Society of Medicine, London, October 13, 2016.

Statistical methods to calculate odds ratios (OR) and 95% confidence intervals (CIs), to visualize risks using restricted cubic splines, and to calculate trends in incidence using joinpoint regression analysis, are presented in our different cited articles. Random-effects model was used for all meta-analyses using StataSE 12.1 (Stata/SE 12.1 for Windows; Stata Corp., College Station, TX, USA).

3. Results

Go to:

3.1. Strength

The first viewpoint discussed by Hill is strength of an association. Table 2 gives results for highest cumulative use in hours for mobile phones. Note that in our study cordless phones were included in the wireless category [38]. The highest group of cumulative use in Coureau et al. [39] was ≥896 h (10th percentile) as compared to Interphone [2] ≥1,640 h (10th percentile). The results in Hardell and Carlberg [38] were recalculated using the same category for highest cumulative exposure as in Interphone [2]. The meta-analysis yielded OR = 1.90, 95% CI = 1.31–2.76. The results are consistent with a statistically significant increased risk for glioma. The study by Turner et al. [40] was a reanalysis of only parts of the Interphone data and was not included in this meta-analysis.

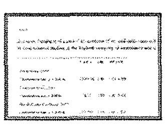


Table 2
Strength. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for glioma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

Strength of association is also supported by a 5-country study as part of Interphone on glioma risk in relation to estimated RF brain tumour dose from mobile phones [15]. In case-case analyses comparing tumours in the highest exposed area with tumours located elsewhere the OR for glioma in the highest exposed area was highest in the group with longest use, 10+ years, yielding OR = 2.80, 95% CI = 1.13–6.94.

In a case-control study on brain tumours among patients aged 7–19 years at the time of diagnosis an elevated risk was found based on operator recorded use of mobile phone; OR = 2.15, 95% CI = 1.07–4.29 in the longest latency group >2.8 years [41]. The result was based on only 24 exposed cases and 25 exposed controls. Type of brain tumour was not reported among these cases.

3.2. Consistency

Similar results should be found by different research groups and in different populations. The Interphone study group included 13 different countries, whereas Coureau et al. [39] covered four areas in France and Hardell and Carlberg [38] covered Sweden. It should be noticed that there was no overlapping of subjects between our studies and the Swedish part of Interphone. In these three different studies there is a consistent finding of increased glioma risk increasing with latency, Table 3. The highest OR was found with the longest latency, 10+ years. Meta-analysis gave OR = 1.62, 95% CI = 1.20–2.19 in the longest latency group. The result was based on 732 exposed cases and 1,279 exposed controls.

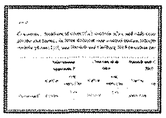


Table 3

Consistency. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for glioma and latency in three different case-control studies, Interphone 2010 (mobile phone) [2], Coureau et al. 2014 (mobile phone) [39], and ...

Inclusion criteria for cases and controls differed between Interphone [2] and our study [38]. Thus we included subjects 20–80 years in contrast to Interphone including the age group 30–59 years. Furthermore Interphone disregarded use of cordless phones in contrast to our studies assessing use of wireless phones: mobile phones and cordless phones. We analyzed our material in the age group 30–59 years and included use of cordless phones in the "unexposed" group in our study for the time period 1997–2003 [10]. This yielded similar results for glioma in both studies, for example, in Interphone ipsilateral cumulative mobile phone use ≥1,640 h OR = 1.96, 95% CI = 1.22–3.16 and in our study OR = 2.18, 95% CI = 1.09–4.35; contralateral use OR = 1.25, 95% CI = 0.64–2.42 and OR = 1.48, 95% CI = 0.57–3.87, respectively. Similar results were also found for glioma in the temporal lobe; see Table 2 in Hardell et al. [42].

3.3. Specificity

Specificity deals with specific exposure and particular sites and types of the disease. Here we analyze only RF radiation. According to one study the temporal lobe is mostly exposed during use of the handheld mobile phone; see Table 4 [43]. Thus, highest glioma risk would be expected for tumours in the temporal lobe.

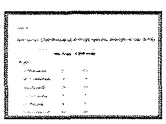


Table 4

Specificity. Distribution of average specific absorption rate (SAR): %.

Table 5 shows highest risk in the temporal lobe in studies from three research groups. Results are given for the highest group of cumulative use for glioma in the temporal lobe with similar findings.

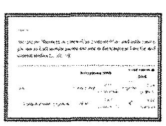


Table 5

Specificity. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for glioma and all mobile phone use and in the temporal lobe for mobile phone use ≥ 1,640 h, in three different case-control studies ...

As also discussed above under Strength, Cardis et al. [15] gave results for glioma in the highest exposed area of the brain based on estimated RF radiation dose. OR increased with time since start of mobile phone use yielding highest risk in the 10+ latency group.

The Interphone study included 13 countries during the study period 2000–2004. The major results were published after a delay of 6 years in 2010 [2]. In a new publication the intracranial distribution of glioma in relation to RF radiation from mobile phones was analyzed [44]. Tumour localization for 792 regular mobile phone users was analyzed in relation to distance from preferred ear for mobile phone use. Five categories for the distance were used with ≥115.01 mm as the reference category ($\alpha = 1.0$). The α values represent the change in risk of observing a tumour within the given interval in comparison with the baseline intensity. An association with distance from preferred side of mobile phone use to center of tumour was found; the closer the distance, the higher the risk. The highest risk was found in the group with the closest distance (0–55 mm) yielding $\alpha = 2.37$, 95% CI = 1.56–4.56. Tumour size, duration of phone use, cumulative phone use, and cumulative number of calls were analyzed. Although no statistically significant differences were found overall, higher risks with decreasing distance were found in the upper levels of these dichotomized covariates; see Table 6 showing results for the shortest distance group (0–55 mm).

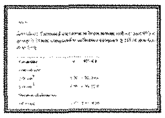


Table 6
Specificity. Estimated elevation in brain tumour risk (α) and 95% confidence interval (CI) in shortest distance group 0–55 mm compared to reference category ≥ 115.01 mm from preferred ear to tumour center. Based ...

Our case-control studies included all types of brain tumours reported to the Swedish Cancer Register regardless of tumour type [38]. Assessment of exposure was used without knowledge of tumour type. We found no consistent evidence of increased risk for meningioma associated with use of wireless phones. In one analysis, meningioma cases ($n = 1{,}624$) were used as the reference entity to glioma cases ($n = 1{,}379$). Table 7 shows a statistically significant increased risk for glioma associated with ipsilateral use of all phone types. Ipsilateral mobile phone use gave OR = 1.40, 95% CI = 1.06–1.84, and ipsilateral cordless phone OR = 1.42, 95% CI = 1.06–1.90. Thus the association between RF radiation and brain tumour risk was specific for glioma.

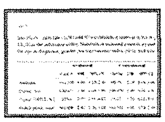


Table 7
Specificity. Odds ratio (OR) and 95% confidence interval (CI) for glioma ($n = 1{,}379$) and meningioma cases ($n = 1{,}624$) as the reference entity. Numbers of exposed cases (Ca) and controls (Co) are given. Adjustment was made for age at diagnosis, gender, ...

3.4. Temporality

The temporal association between exposure and disease is important. Both initiation and promotion/progression of the disease are of relevance. Table 8 shows highest risk in the group with longest latency (time from first exposure to disease). Our study is the only one with results for latency >20 years for wireless phone use yielding OR = 2.01, 95% CI = 1.41–2.88. Also Interphone [2] and Coureau et al. [39] showed increasing risk with latency.

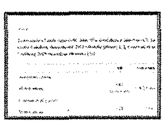


Table 8
Temporality. Odds ratio (OR) and 95% confidence interval (CI) for latency and glioma risk in three different case-control studies, Interphone 2010 (mobile phone) [2], Coureau et al. 2014 (mobile phone) [39], and Hardell and Carlberg 2015 (wireless phones) ...

We used restricted cubic splines to visualize the relationship between latency and cumulative ipsilateral use of mobile phone. The results for latency and ipsilateral mobile phone use show that there was an increased OR with short latency and after some decline an increasing risk with longer latency (nonlinearity, $p = 0.01$); see Figure 1 [38]. This finding is different from the result for contralateral mobile phone use; see Figure 2 (nonlinearity, $p = 0.76$). The results were similar for cordless phone use, data not in figures (ipsilateral, nonlinearity, $p = 0.04$; contralateral, nonlinearity, $p = 0.26$). It should be noted that contralateral use was defined as >50% use on the opposite side of the head compared to the tumour localization. Thus, in spite of being coded as contralateral exposure some ipsilateral tumour exposure (less than 50%) may have occurred. These results are in contrast to meningioma risk with OR close to unity regardless of latency, Figure 3; see also Specificity above.

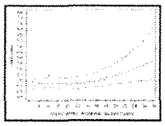


Figure 1
Restricted cubic spline plot of the relationship between latency of ipsilateral mobile phone use and glioma. The solid line indicates the OR estimate and the broken lines represent the 95% CI. Adjustment was made for age at diagnosis, gender, socioeconomic ...

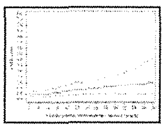


Figure 2
Restricted cubic spline plot of the relationship between latency of contralateral mobile phone use and glioma. The solid line indicates the OR estimate and the broken lines represent the 95% CI. Adjustment was made for age at diagnosis, gender, socioeconomic ...

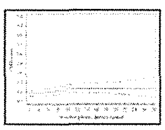


Figure 3
Restricted cubic spline plot of the relationship between latency of wireless phones and meningioma. The solid line indicates the OR estimate and the broken lines represent the 95% CI. Adjustment was made for age at diagnosis, gender, socioeconomic index ...

3.5. Biological Gradient

Sir Bradford Hill mentioned that if the association shows a biological gradient, dose-response, it should be more carefully considered. Interphone [2] included 2,708 cases and 2,972 controls in the analysis. In the last decile of cumulative exposure ≥1,640 h a statistically significant increased risk for glioma was found, OR = 1.40, 95% CI = 1.03–1.89; see Table 9. In the other categories of cumulative use a decreased risk was found. Bias and confounding were discussed as potential reasons for that. Analyzing only subjects with regular use of a mobile phone yielded OR = 1.82, 95% CI = 1.15–2.89 in the group with highest cumulative use. There was an age difference between cases and controls in the Interphone material and furthermore cases and the matched controls were interviewed at different time periods, controls usually later than cases. This is problematic for mobile phones with rapid penetration of the use in the population. In an alternative analyses cases and controls nearest in age and time for interview were included [40]. The association between mobile phone use and glioma was strengthened thereby. Thus among regular users in the 10th decile (≥1,640 h) cumulative use gave OR = 2.82, 95% CI = 1.09–7.32.

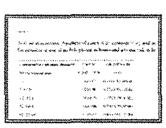


Table 9
Biological Gradient. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for cumulative

use of mobile phone in hours and glioma risk in Interphone [2].

Also Coureau et al. [39] found highest risk in the highest group of cumulative use, ≥896 h, with OR = 2.89, 95% CI = 1.41–5.93 with a statistically significant trend ($p = 0.02$); see Table 10. The results were based on 253 participating cases and 504 participating controls.

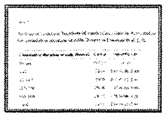


Table 10
Biological Gradient. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for cumulative duration of calls (hours) in Coureau et al. [39].

We divided cumulative use in hours of wireless phones into quartiles. The results were based on 1,380 responding glioma cases and 3,530 responding controls [38]. For both mobile and cordless phones the highest risk was found in the fourth quartile with a statistically significant trend; see Table 11.

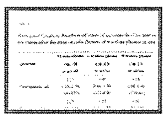


Table 11
Biological Gradient. Numbers of cases (Ca), controls (Co), and odds ratio (OR) with 95% confidence interval (CI) for cumulative duration of calls (hours) of wireless phones in quartiles in Hardell and Carlberg [38].

3.6. Plausibility

One aspect on association or causality is if the disease is biologically plausible. The IARC evaluation in May 2011 [4, 5] concluded that there is *"limited evidence in experimental animals for the carcinogenicity of radiofrequency radiation"*; see page 419 [5].

Effects on tumour susceptibility in mice exposed to a UMTS (universal mobile telecommunications system) test signal from fetal time for up to 24 months were studied by Tillmann et al. [45]. Animals were exposed to UMTS fields with intensities of 0, 4.8, and 48 W/m^2. The low-dose group, 4.8 W/m^2, was subjected to additional prenatal ethylnitrosourea (ENU) treatment. The ENU-treated group and UMTS-exposed at 4.8 W/m^2 showed an increased lung tumour rate and an increased incidence of lung carcinomas as compared to the controls treated with ENU only. The authors concluded that the study showed a cocarcinogenic effect of lifelong UMTS exposure in female mice subjected to pretreatment with ENU. This study was included in the IARC evaluation.

The results by Tillmann et al. [45] gained further interest based on the results in a follow-up study published in 2015 [46]. The exposure levels were 0 (sham), 0.04, 0.4, and 2 W/kg SAR. Numbers of tumours of the lungs and livers and malignant lymphoma in exposed animals were statistically significant higher than in sham-exposed controls. A tumour-promoting effect from RF radiation was found at low to moderate levels (0.04 and 0.4 W/kg SAR), well below exposure limits for users of mobile phones [46].

A report was released from The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in USA on the largest ever animal study on cell phone RF radiation and cancer [47]. An increased incidence of glioma in the brain and malignant schwannoma in the heart was found in rats. Acoustic neuroma or vestibular schwannoma is a similar type of tumour as the one found in the heart, although benign. These results have gained considerable interest since epidemiological human studies have in addition to glioma also found an increased risk for acoustic neuroma, also called vestibular schwannoma [48].

In a study published in 2013 exposure to 1,800 MHz RF radiation induced oxidative DNA base damage in a mouse spermatocyte-derived cell line [49]. There was a concomitant increase in reactive oxygen species (ROS). This effect was mitigated by cotreatment with the antioxidant α-tocopherol. The authors concluded that RF radiation with insufficient energy for the direct induction of DNA strand breaks can give genotoxicity through oxidative DNA base damage.

Yakymenko et al. [50] showed in a review of 100 studies investigating oxidative effects of low-intensity RF radiation in living cells that exposure down to 2,500 μW/m^2 [51] and with SAR values down to 600 μW/kg [52, 53] could increase oxidative stress in the cells. It should be noted that the guideline for mobile phone SAR is 2 W/kg. The 2 W/kg guideline is in any 10 g of tissue while in the US (FCC guideline) the exposure limit value is 1.6 W/kg in 1 g of tissue. Certainly these results on oxidative stress are of concern since ROS are of crucial importance in carcinogenesis.

3.7. Coherence

Hill points out that an association would be strengthened if an exposure changes the biology and natural history of the disease. One interesting gene is the *p53* protein. It is a transcription factor that plays a vital role in regulating cell growth, DNA repair, and apoptosis, and *p53* mutations are involved in disease progression. In a study it was found that use of mobile phones for ≥3 hours a day was associated with increased risk for the mutant type of *p53* gene expression in the peripheral zone of glioblastoma multiforme, the most malignant glioma type. Furthermore, this mutation increase was statistically significant correlated with shorter overall survival time [54].

We analyzed survival of 1,678 glioma patients in our 1997–2003 and 2007–2009 case-control studies [55]. Use of wireless phones in the >20 years' latency group (time since first use) gave a reduced survival yielding hazard ratio (HR) = 1.68, 95% CI = 1.23–2.29 for glioma; see Table 12. For glioblastoma multiforme (high-grade glioma; n = 926) mobile phone use yielded HR = 1.99, 95% CI = 1.37–2.91 and cordless phone use HR = 3.37, 95% CI = 1.04–11 in the same latency category. The hazard ratio for glioblastoma multiforme increased statistically significant per year of latency for wireless phones, HR = 1.020, 95% CI = 1.007–1.033, and of borderline statistical significance per 100 h cumulative use, HR = 1.002, 95% CI = 0.999–1.005. The hazard ratio was highest in the age group <20 years for first use of a wireless phone; see Table 13.

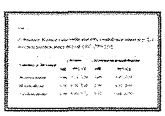


Table 12
Coherence. Hazard ratio (HR) and 95% confidence interval (CI) for survival of patients with glioma and use of wireless phones, study period 1997–2009 [55].

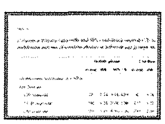


Table 13
Coherence. Hazard ratio (HR) and 95% confidence interval (CI) for survival of patients with glioblastoma multiforme and use of wireless phones in different age groups, study period 1997–2009 [55].

In contrast for low-grade astrocytoma (grades I-II; n = 228) decreased HR (increased survival) was found for mobile phone use HR = 0.50, 95% CI = 0.29–0.88 and cordless phone use HR = 0.60, 95% CI = 0.34–1.07, and for wireless phones in total statistically significant decreased HR = 0.57, 95% CI = 0.34–0.94. The reason for the survival benefit for cases with astrocytoma grades I-II associated with use of both mobile and cordless phones is unclear. However, surgery is crucial for survival in patients with low-grade astrocytoma that may transform to high-grade glioma in the long term. An earlier treatment gives a better prognosis. Tumour promotion from RF radiation might give earlier symptoms leading to surgery. For 144 (63%) of the 228 cases with low-grade astrocytoma it was possible to calculate tumour volume based on CT/MRI scans [55]. This gave for cases exposed to wireless phones ($n = 121$) median volume = 25.1 cm^3 (mean = 37.7, range = 0.15–179.6) compared with unexposed cases ($n = 23$) median volume = 18.3 cm^3 (mean = 33.1, range = 0.79–125.7). Although the difference was not statistically significant (p, Wilcoxon rank-sum test = 0.82), these results indicate tumour promotion from RF radiation since the median tumour volume was 37.2% larger in exposed cases. This might cause tumour awareness and earlier surgery.

Also for glioblastoma multiforme the median tumour volume was larger in exposed cases ($n = 346$) than in unexposed cases ($n = 112$), 25.6 versus 22.0 cm^3, that is, 16.4% larger volume, p, Wilcoxon rank-sum test = 0.68 [55]. This tumour type is extremely malignant with median survival in the range of 6 months in spite of surgery and radio- and chemotherapy [56]. Thus early detection does not significantly change the prognosis.

It has been suggested that overall incidence data on brain tumours for countries may be used to qualify or disqualify the association between mobile phones and brain tumours observed in case-control studies. During recent years such opinions have been published by different study groups. However, it must be stressed that descriptive epidemiology with no individual exposure data is of less value than results in analytical epidemiology such as case-control studies. Studies should primarily be aimed at investigating incidence in the most exposed part of the brain, the temporal lobe. Of special interest is the incidence of the most malignant glioma type, glioblastoma multiforme. We have discussed this in previous publications, for example, [37, 57]. In England increasing incidence of glioblastoma multiforme, especially in the frontal and temporal lobes, during 2003–2013 has been found; see Figure 4. Of interest is that a real increase in the incidence of glioblastoma multiforme in frontal and temporal lobes and cerebellum was reported in USA [58].

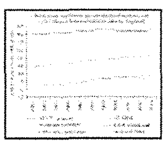


Figure 4

Graphical data on age-standardized incidence rate of glioblastoma multiforme in England 2003–2013. Data provided by Alasdair Philips. A detailed analysis is under publication.

No increasing incidence of brain tumours has been recorded in the Swedish Cancer Register. We have discussed the many shortcomings in the reporting of new cases elsewhere [59]. Using the Swedish Inpatient Register (IPR) we found an increasing rate of patients with D43 = tumour of unknown type in the brain or CNS with joinpoint in 2007; see Figure 5. A joinpoint was found in 2008 for increasing death rate of D43 in the Swedish Causes of Death Register, Figure 6. No histopathology is available for these cases but they may represent glioblastoma multiforme based on results in IPR with joinpoint in 2007 and the short survival for these patients.

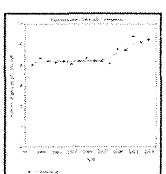


Figure 5

Joinpoint regression analysis of number of patients per 100,000 inhabitants according to the Swedish National Inpatient Register for both genders combined, all ages during 1998–2013 diagnosed with D43 = tumour of unknown type in the brain or CNS ...

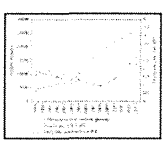


Figure 6

Number of outgoing mobile phone minutes in millions during 1999–2013 and joinpoint regression analysis of age-standardized death rates per 100,000 inhabitants according to the Swedish Causes of Death Register for all ages during 1999–2013 ...

In an ecological study from England annual incidence of brain tumours in the temporal and parietal lobes was modelled based on population-level covariates. The study period was 1985–2014. Malignant brain tumours in the temporal lobe increased faster than would be expected. Using a latency period of 10 years this increase was related to the penetration of mobile phone use. This corresponded to an additional increase of 35% (95% credible interval 9%; 59%) or 188 (95% CI 48–324) additional cases annually [60]. The author concluded that the findings were in agreement with mobile phones and other wireless equipment being causing factors.

3.8. Experiment

Sir Bradford Hill discussed in his paper if prevention has an effect on the risk. Relating to wireless phones no such community experiment exists. Antioxidants such as melatonin, vitamin C, and vitamin E (α-tocopherol) may alleviate the generation of ROS [49, 61]. There are however no studies if persons taking antioxidants and using wireless phones have a reduced risk for glioma.

Mobile phones were introduced in Sweden in the early 1980s. First, it was very common to use the phone in a car with external antenna without any use outside the car. In our first study period 1997–2000 a number of cases and controls had only used the mobile phone in a car with external antenna. In addition one control reported always use of a hands-free device [8]. They were regarded as unexposed to RF radiation. Brain tumour risk in this group was calculated to crude OR = 0.82, 95% CI = 0.59–1.15.

3.9. Analogy

The last viewpoint by Bradford Hill is analogy. Is there some evidence with another similar exposure? One analogy would be glioma risk associated with extremely low-frequency electromagnetic fields (ELF-EMF). In 2002 IARC classified ELF-EMF as "possibly carcinogenic to humans," Group 2B based on an increased risk for childhood leukemia [62]. More recently a pooled analysis showed about twofold increased risk for childhood leukemia at exposure level above 0.3–0.4 μT [63], further supporting a carcinogenic potential from ELF-EMF.

ELF-EMF is generated by alternating electric currency and humans may be exposed both during leisure time and in different occupational settings. In an evaluation of epidemiological findings on exposure to ELF-EMF it was concluded regarding glioma that an increased risk was seen in electric and electronics industries [64].

Based on occupational history it was possible to calculate ELF-EMF job exposure for cases and controls using a job-exposure matrix (JEM) both in Interphone [65] and in our studies [66].

In the international Interphone study glioma was associated with occupational ELF-EMF exposure in recent time windows whereas no increased risk was found for meningioma [65]. The authors concluded that such exposure may play a role in late stage carcinogenesis of glioma.

The results in our studies were based on 1,346 glioma cases and 3,485 population based controls [66]. Cumulative exposure (≥90th percentile versus <25th percentile) increased the risk for glioblastoma multiforme in 5-year time windows (data not in table) up to 14 years; see Table 14 for time windows 1–14 and 15+ years.

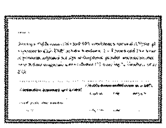


Table 14

Analogy. Odds ratio (OR) and 95% confidence interval (CI) for glioblastoma multiforme for occupational exposure to ELF-EMF in time windows; 1–14 years and 15+ years before diagnosis. Unconditional logistic regression, adjusted for age at diagnosis, ...

With longer latency periods (15+ years) no statistically significant increased risk and trend were found. For low-grade glioma no statistically significant increased risk was seen in the different time windows. In conclusion this study showed an increased risk in late stage (promotion/progression) of glioblastoma multiforme for occupational ELF-EMF exposure.

4. Discussion

Go to:

In this review we considered all nine viewpoints by Bradford Hill on association or causation regarding use of wireless phones and glioma risk. It is an update of our article from 2013 on this issue [37] since more scientific evidence has emerged since then. As discussed above after the IARC evaluation in 2011 concluding RF radiation to be "possibly carcinogenic" to humans several organizations have stated that the association has been weaker or even no consistent evidence for an increased risk for brain tumours. This has in part been based on a much criticized Danish cohort study on persons with mobile phone subscriptions and assumed mobile phone use with funding from the telecom industry [67]. The study was not based on sound epidemiological principles and had several methodological limitations mainly due to poor exposure assessment that render it to be uninformative at best [68]. Some of the many shortcomings include the following.

1. Corporate subscribers of mobile phones (200,507 people), which are likely to have been heavy users, were classified as "unexposed."
2. Mobile phone subscription holders not using the phone were classified as "exposed."
3. Users of cordless phones not using a mobile phone were classified as "unexposed."
4. Nonsubscribers using the mobile phone were classified as "unexposed."
5. Persons with a mobile phone subscription later than 1995 were classified as "unexposed."
6. No individual exposure data were assessed (e.g., on cumulative exposure or side of head mostly used).
7. No operator-verified data on years of subscription were assessed.

These limitations are likely to have led to an underestimate of any risk in this study. One would expect considerable misclassification of mobile phone use both among subscribers and the reference population since no new subscribers were included in the exposed cohort after 1995. We stated that "*after reviewing the four publications on the Danish cohort study, one might rightly wonder whether this cohort was initially set up to show no increased risk.*" A similar conclusion was made by IARC in the 2011 evaluation, thus stating that using the "*reliance on subscription to a mobile-phone provider, as a surrogate for mobile phone use, could have resulted in considerable misclassification in exposure assessment*" [4]. The Danish cohort study should no longer be cited as scientific evidence on no increased risk for glioma among mobile phone users.

A study in UK published in 2013 has been included in the *no risk* paradigm [69]. Use of mobile phones was assessed in about 65% of a cohort of women established for other purposes during 1996–2001. Only baseline data collected at one time between 1999 and 2005 were used with the questions: "*About how often do you use a mobile phone?*" (never, less than once a day, every day) and "*For how long have you used one?*" (total years of use). In 2009, the participants were asked how much they did talk on a mobile phone and how many years they had used the phone. However, these later data were not used in the analysis. Of those reporting no use of a mobile phone at baseline, 49% reported such use in 2009. The incidence of brain tumours was assessed in 2005 and the average follow-up was only 7 years. No increased incidence of glioma was found ($n = 571$ cases). For acoustic neuroma ($n = 96$ cases), there was an increase in risk with long term use versus never use (10+ years: relative risk (RR) $= 2.46$, 95% CI = 1.07–5.64, $p = 0.03$), the risk increasing with duration of use (trend among users, $p = 0.03$). No data were available on handedness for mobile phone use or tumour localization in the brain. Use of cordless phones was ignored. This study had poor assessment of exposure and has the same shortcomings as the Danish cohort study. Benson et al. gave in a letter to the Editor updated follow-up data to 2011 [70]. They found no longer a statistically significant increased risk for acoustic neuroma. However, these results were based on the same baseline data as previously and similarly lack scientific precision in the assessment of exposure. Due to the many shortcomings this study should not be cited as evidence of no increased risk for glioma among mobile phone users.

Not all are careful in the evaluation of scientific evidence on RF radiation and glioma risk. Repacholi et al. in their article published on line 2011 included the Danish cohort study in the review on glioma risk [23]. They stated that they included also cordless phone use although no results were presented from the German part of Interphone claimed to have assessed cordless phone use. We have found in our studies a consistent increased glioma risk associated with use of cordless phones [38]. However, Repacholi et al. stated that "*most of the studies from the Hardell group report an association whereas other studies do not. The reason for this is unclear.*" One reason is that the other studies like Interphone did not report use of cordless phones thus diminishing the risk towards unity [71]. In fact, the results in the Hardell group studies are similar to Interphone and Coureau et al.; see Tables 2, 3, 5, and 8. Repacholi et al. considered the Hill viewpoints thereby excluding some of the viewpoints and modifying others. They concluded that "*in summary, none of the Hill criteria support a causal relationship between wireless phone use and brain cancers or other tumors in the areas of the head that most absorb the RF energy from wireless phones. Accordingly, the conclusions and recommendations of WHO [2011] provide adequate protective measures, and the ICNIRP guidelines limiting exposure to RF fields [ICNIRP, 1998, 2009b] continue to provide a sound, science-based standard for public health policy regarding the use of wireless phones by adults.*" Obviously this conclusion is not based on an understanding and thorough evaluation of Hill's viewpoints. At best it might be an example of misunderstanding scientific evidence without basic knowledge in pathology and oncology. The practice to misuse Hill's viewpoints (misinterpreted as criteria for causation) has been discussed by Kundi [72].

In contrast to the Repacholi et al. publication [23] we have used the original Hill viewpoints without modification or exclusions. That would give a more decent and true evaluation based on these viewpoints. Regarding *strength* Hill wrote that "*we must not be too ready to dismiss a cause-and-effect hypothesis merely on the ground that the observed association appears to be slight.*" Our analysis showed doubled risk for glioma in the group with highest cumulative exposure; see Table 2. Thus similar results were found in different populations by different study groups.

Regarding *consistency*, Bradford Hill wrote that the observed association has been "*repeatedly observed by different persons, in different places, circumstances and times.*" As can be seen in Table 3 consistency was found not only for cumulative use but also for latency.

Specificity is a "*strong argument in favour of causation*" according to Hill. Ipsilateral exposure to RF radiation in the temporal lobe is the area with highest exposure to RF radiation. There is a consistent finding of increased risk for use of the wireless phone on the same side as the tumour occurred. This risk is confirmed in analysis of glioma risk in the temporal lobe, and also using distance to the mobile phone and estimated total cumulative specific energy in J/kg [15]. Furthermore the risk is specific for glioma using meningioma cases as the comparison group in the same study [38].

The *temporal* relationship of the association is important. Thus, exposure should precede the disease outcome. In carcinogenesis also latency (time from exposure to glioma diagnosis) is of relevance. Clearly OR increased with latency in the case-control studies with highest risk in the 20+ group [38]. The maximum latency was shorter in Interphone [2] and Coureau et al. [39] but still yielded highest risk.

A *biological gradient*, dose-response, should be found. In the case-control studies a statistically significant trend with increasing call time in hours was reported by Coureau et al. [39] and in our study

[38]. In Interphone a statistically significant increased risk was only found in the 10th decile of cumulative use ≥1,640 hours. Also restricting the analysis to subjects with regular mobile phone use gave highest risk in the same group, OR = 1.82, 95% CI = 1.15–2.89. No trend analysis was reported; see Appendix 2 [2]. In the alternative post hoc matching of cases and controls in Interphone (closest in age and time for interview) the 10th decile of cumulative use gave OR = 2.82, 95% CI = 1.09–7.32 [40].

For *plausibility* Hill stated that "*it will be helpful if the causation we suspect is biologically plausible. But this is a feature I am convinced we cannot demand. What is biologically plausible depends upon the biological knowledge of the day.*" By now there are studies showing a cocarcinogenic and tumour-promoting effect from RF radiation. One postulated mechanism would be generation of ROS that can give base-pair damage of DNA. These effects have been shown in several experimental studies with RF radiation levels well below current guideline for exposure during use of mobile phones.

For *coherence* the natural history and biology of the disease are evaluated. One interesting aspect is the increased risk for the mutant type of the *p53* gene expression in glioblastoma multiforme associated with use of mobile phones [54]. The mutation is involved in disease progression and shorter survival was found in patients with the mutant gene. This finding is of large interest in relation to our result showing shorter survival in patients using mobile or cordless phones [55]. The age group <20 years for first use of the wireless phone had the highest hazard ratio, that is, the strongest reduction in survival. The tumour volume was larger in glioma cases using wireless phones compared with nonusers. It should also be noted that α was higher in larger glioma tumours with shortest distance from preferred ear to tumour center which might be an effect of tumour promotion [44]. Several studies have shown an increasing incidence of glioma, especially glioblastoma multiforme in the temporal lobe. These facts show a change in the natural history of the disease.

It is difficult to perform an *experiment* for a rare disease like glioma. Thus, the risk would be studied among persons that have stopped use of wireless phones and analyze a possible risk reduction over time as seen for lung cancer risk in ex-smokers. Such a cohort study is in practice almost impossible to perform, especially for a rare disease like brain tumour. Some indirect evidence might be found by the finding in our study that use of mobile phone in a car with external antenna and no other use of a wireless phone (no exposure to RF radiation) gave no increased brain tumour risk [8]. This finding, as well as the alleviation of ROS production from RF radiation by antioxidants, might be proxies for experiment.

The last viewpoint by Hill is *analogy*. Is there glioma risk with similar exposure? ELF-EMF has been classified as *possibly human carcinogen*, Group 2B by IARC in 2002 [62]. Based on occupational ELF-EMF exposure an increased risk for glioma has now been found in two case-control studies [65, 66].

5. Conclusion

Go to:

The nine Bradford Hill viewpoints on association or causation regarding RF radiation and glioma risk seem to be fulfilled in this review. Based on that we conclude that glioma is caused by RF radiation. Revision of current guidelines for exposure to RF radiation is needed.

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Disclosure

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests

Go to:

The authors declare that there is no conflict of interests regarding the publication of this paper.

Authors' Contributions

Go to:

Both authors have read and approved the final manuscript.

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Appendix G2: NTP's Responses to NIH Reviewer's Comments

NTP Responses to Pathology Reviewer' Comments April 12, 2016

Reviewers: R. Mark Simpson, D.V.M., Ph.D. and Diana Copeland Haines, D.V.M.

Responses Relating to the Pathology Review Process

Drafts of the PWG reports are provided. As described in the PWG report, the specific task of the first PWG (January 29th 2016) was to: 1) confirm the presence of glial cell hyperplasia and malignant gliomas in the brain and Schwann cell hyperplasia and schwannomas in the heart; 2) develop specific diagnostic criteria in the brain for distinguishing glial cell hyperplasia from malignant glioma and gliosis, and in the heart for distinguishing between Schwann cell hyperplasia and schwannoma. The PWG participants confirmed the malignant gliomas and schwannomas, but the criteria for distinguishing between hyperplasia and neoplasia differed between the participants.

In order to clearly establish specific diagnostic criteria for the differentiation between hyperplastic and neoplastic lesions in the brain and heart, two additional PWGs were convened. The participants for the second (February 25, 2016) and third (March 3, 2016) PWGs were selected based on their distinguished expertise in the fields of neuropathology and cardiovascular pathology, respectively. Some of the participants were leaders in the International Harmonization of Nomenclature and Diagnostic Criteria initiative. The neuropathology experts of the second PWG confirmed the malignant gliomas in the brain, established diagnostic criteria for glial cell hyperplasia, and agreed that the hyperplastic lesions are within a continuum leading to malignant glioma. The cardiovascular pathology experts of the third PWG established specific diagnostic criteria for Schwann cell hyperplasia and schwannoma in the endocardium and myocardium, and reviewed and confirmed all cases of Schwann cell hyperplasia and schwannoma observed in these studies. The outcome of the PWG provided very high degree of confidence in the diagnoses.

The participants of the first PWG (January 29th 2016) only reviewed a subset of the glial lesions that were observed in the studies. The review for the second PWG (February 25, 2016) included all glial lesions in the studies including the subset that was reviewed in the first PWG.

Responses Relating to Considerations of Historical Control Data

For NTP toxicology and carcinogenicity studies, the concurrent controls are always the primary comparison group. However, historical control information is useful particularly in instances when there is differential survival between controls and exposed groups, as was observed in the RFR studies. Rates for glial cell neoplasms and heart schwannomas from control groups of male Harlan Sprague Dawley rats from other recently completed NTP studies are presented in Appendix D of the 3-16-2016 draft report. While Harlan Sprague Dawley rats are an outbred strain, they are considered single genetic strain in the same sense as other outbred strains, such as the Long-Evans or Wistar rat. Therefore, these historical control tumor rates are applicable to this study. However, it's important to note that the studies listed in Appendix D were carried out at laboratories other than the RFR studies, and under different housing and environmental conditions. At the time of the 3-16-201 draft report, not all of these studies had undergone a complete pathology peer review. In the past several weeks NTP pathologists have reviewed brain and heart slides from these male rat control groups, and have confirmed, with few exceptions, the low rates of hyperplastic and neoplastic lesions reported in Appendix D, applying the diagnostic criteria established during the PWGs outlined in Appendix C.

NTP Comments on Statistical Issues Raised by the Reviewers April 12, 2016

Given the multiple comparisons inherent in this kind of work, there is a high risk of false positive discoveries (Michael S. Lauer).

Although the NTP conducts statistical tests on multiple cancer endpoints in any given study, numerous authors have shown that the study-wide false positive rate does not greatly exceed 0.05 (Fears et al., 1977; Haseman, 1983; Office of Science and Technology Policy, 1985; Haseman, 1990; Haseman and Elwell, 1996; Lin and Rahman, 1998; Rahman and Lin, 2008; Kissling et al., 2014). One reason for this is that NTP's carcinogenicity decisions are not based solely on statistics and in many instances statistically significant findings are not concluded to be due to the test agent. Many factors go into this determination including whether there were pre-neoplastic lesions, whether there was a dose-response relationship, biological plausibility, background rates and variability of the tumor, etc. Additionally, with rare tumors especially, the actual false positive rate of each individual test is well below 0.05, due to the discrete nature of the data, so the cumulative false positive rate from many such tests is less than person would expect by multiplying 0.05 by the number of tests conducted (Fears et al., 1977; Haseman, 1983; Kissling et al., 2015).

I'm getting slightly different values for poly-k adjusted denominators (Michael S. Lauer).

I compared poly---3 adjusted number from Table 3 in the original report versus the poly---3 adjusted number that I calculated using the raw data from the excel files. Supplementary Figure S1 shows that these two sets of numbers agree with each other in general. This is in contrast to the comparison for poly---6 adjusted number from Table 1 in the original report versus the poly---6 adjusted number that I calculated using the raw data from the excel files (Supplementary Figure S2). In fact, the adjusted rat numbers from Table 1 and Table 3 of the original report look quite similar (Supplementary Figure S3). This suggests that the poly---3 adjusted number was used in the footnotes in both Table 1 and Table 3 in the original report. (Max Lee)

I noted that in Table S2 the adjusted numbers in from.original.report and poly3 are identical at Dose 0 and 1.5 for both CDMA and GSM as well as at Dose 3 for GSM but differ slightly in the other treatment doses for heart schwannomas. One possible cause of the difference is that the version of the raw data in the excel files differs from that used to generate the original report. The second possibility is typo in the footnote in Table 3. I also generated Table S3 that has the poly---6 adjusted numbers for brain gliomas. The two sets of the poly---6 adjusted numbers are very different. (Max Lee)

Information could be included regarding the software or programming environment used for the computations. (Aleksandra M. Michalowski)

The adjusted denominators in Table of the original report were labeled as poly-6 denominators, but were actually poly-3 denominators. This error was noted and brought to Dr Tabak's attention by Dr. Bucher in a March 22 email.

The p-values and adjusted denominators calculated by NTP are correct, except as noted for Table 1, and were calculated using validated poly-k software. This software is coded in Java and is embedded within NTP's TDMSE (Toxicology Data Management System Enterprise) system. Poly-k

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

calculations conducted by the reviewers in R may vary slightly from the NTP's calculation due to selection of study length and the NTP's use of the Bieler-Williams variance adjustment and a continuity correction. In his calculations, Dr. Lauer used 90 weeks as the study length, whereas the actual study length was 10 weeks. It is not apparent from the R documentation that the Bieler-Williams adjustment or the continuity correction is incorporated into the poly-3 calculations in R. In his calculations, Dr. Lee used two-sided p-values. In NTP statistical tests for carcinogenicity, the expectation is that if the test article is carcinogenic, tumor rates should increase with increasing exposure; thus, the NTP employs one-sided tests and p-values are one-sided. Using one-sided p-values in Dr. Lee's Table 1, the GSM trend if there were brain glioma in the control group remains nonsignificant, but the CDMA trend approaches 0.05 ($p = 0.054$) if there were brain glioma in the control group. In Dr. Lee's Table 2, the one-sided p-value for the GSM trend if there were 1 heart schwannoma in the control group approaches 0.05 ($p = 0.054$) and the one-sided p-value for the CDMA trend in heart schwannomas remains significant at = 0.018 if there were 1 heart schwannoma in the control group. In Dr. Lee's Table 3, the one-sided p-value for the CDMA pairwise comparison is significant at $p = 0.049$ if there were 1 heart schwannoma in the control group.

statement of the required statistical significance level should be added. FDA guidance suggests the use of significance levels of 0.025 an 0.005 for tests for positive trends in incidence rates of rare tumors and common tumors, respectively; for testing pairwise differences in tumor incidence the use of significance levels of 0.05 and 0.01 is recommended for rare and common tumors, respectively. (Aleksandra M. Michalowski)

Although the FDA guidance suggests lowering the significance level for most tests of trend and pairwise differences, this guidance is based o a misunderstanding of findings reported by Haseman (1983). In this paper, Haseman discusses several rules proposed by others for setting the significance level lower than 0.05. *If* these rules are rigidly followed, Haseman showed that study conclusions will be consistent with the NTP's more complex decision-making process, for which 0.05 is the nominal significance level and p-values are taken into consideration along with other factors (outlined above in response to comment 1) in determining whether the tumor increase is biologically significant. The NTP does not strictly adhere to specific statistical significance level in determining whether a carcinogenic effect is present.

Appendix tables for all poly-k tests performed could be added. (Aleksandra M. Michalowski)

Dr. Michalowski proposed a sample table. The rows corresponding to X, N, adjusted n are already included in the tables or appear the footnotes in the tables. The rows corresponding to "Dunnett contrast" and "Williams contrast" are not appropriate for dichotomous tumor data. Both Dunnett's test and Williams' test assume that the data are continuous and normally distributed.

In the portion of the text describing poly-k test results, p-values are given for significant pairwise comparisons; I would also give the p-values estimated for the significant trends. (Aleksandra M. Michalowski)

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Indicators of significant trends are given in the tables in the form of asterisks next to control group tumor counts.

There are a couple of errors in the footnote of Table 3 in the original report. 2/74.05 (5%) should be 2/74.05 (2.7%). 3/78.67 (4%) should be 3/78.67 (3.8%). (Max Lee)

Thank you for pointing this out. The percentages will be corrected in our final report.

Were control rats selected in utero like the exposed rats were? Were pregnant dams assigned to different groups by formal randomization? How were the pups per litter chosen? (Michael S. Lauer).

believe detailed information about animal selection and randomization procedures should be given so that the potential for allocation bias could be judged. (Aleksandra M. Michalowski)

Pregnant dams were assigned to groups, including the control group, using formal randomization that sought to also equalize mean body weights across groups. The three pups per sex per litter were selected using formal randomization, as well. Tumors in the heart and brain were not observed in littermates, indicating that there was no litter-based bias in the results.

Were all analyses based on the intent-to-treat principle? Were there any crossovers? Were all rats accounted for by the end of the experiment an were all rats who started in the experiment included in the final analyses? (Michael S. Lauer)

The intent-to-treat principle is not relevant to this animal experiment, in which all animals that were assigned to treatment group received the full and equal treatment of that group. There were no crossovers. All animals that started the experiment were accounted for by the end of the experiment and included in the final analyses.

The PWG review blinding was not complete. (Michael S. Lauer)

PWG reviewers were blinded to the identity of the test article and the level of exposure but were not blinded to the fact that there were two different, yet related, test articles (modulations of cell phone RFR), to emphasize the fact that there was a common control group.

Did the authors perform a prospective sample size calculation? (Michael S. Lauer)

If power calculations to determine the required sample size were performed, the results should also be included. (Aleksandra M. Michalowski)

Sample size calculations were conducted for this study. However, for detecting carcinogenesis, sample size and power will depend on the baseline (control) tumor rate and the expected magnitude of the increase in tumors. For example, at 80% power, sample size requirements will be quite different for detecting a 2-fold increase in a rare tumor having a spontaneous occurrence of 0.5% compared to 2-fold increase in a more common tumor having a spontaneous occurrence of 10%. Because many different tumor types having wide range of spontaneous occurrence are involved in these studies, there is no "one-size-fits-all" sample size; rather, the sample size is a compromise among several factors, including obtaining reasonable power to detect moderate to large increases for most tumor types, while staying within budgets of time, space, and funding. A sample of 90 animals per sex per group was selected as providing as much statistical power as possible across the spectrum of tumors, under the constraints imposed by the exposure system.

The NTP's carcinogenicity studies are similar in structure to the OECD's 45 Guideline for carcinogenicity studies and the FDA's guidance for rodent carcinogenicity studies of pharmaceuticals. These guidelines recommend at least 50 animals of each sex per group, but also mention that an increase in group size provides relatively little increase in statistical power. In the NTP's RFR studies, the group sizes were 90 animals of each sex per group, nearly twice as many as the minimum recommendation. Increasing the group sizes further provides diminishing returns, for which additional animals do not substantially increase power.

The low power implies that there is high risk of false positive findings (citing Ioannidis, 2005). ... suspect that this experiment is substantially underpowered and that the few positive results found reflect false positive findings (citing Ioannidis, 2005). (Michael S. Lauer)

It is true that the power is low for detecting moderate increases above a low background tumor rate of approximately – %, as was seen in the brain and heart tumors. However, this low power <u>does not</u> correspond to high risk of false positive findings. The paper by Ioannidis that was cited correctly states that when studies are small or effect sizes are small (i.e., statistical power is low), "the less likely the research findings are to be true." Research findings can be "not true" if the result is a false positive or a false negative. With low statistical power, false negatives are much more likely than false positives. Therefore, the vast majority of false research findings in a low power situation will result from the failure to detect an effect when it exists. The false positive rate on any properly constructed statistical test will not exceed its significance level, alpha. By definition, the significance level of a statistical test <u>is</u> its false positive rate, and it is typically selected by the researcher, often at a low fixed value such as 0.05 or 5%.

If we were repeating the experiment, we may see some control studies have 1 or more tumors. (Max Lee) (Dr. Lee also presented analyses of the male rat data, inserting hypothetical data on one tumor-bearing animal in the control group.)

In light of the historical control data, Dr. Lee demonstrated that several associations became less or not significant with the insertion of a tumor data point in the control group. While we appreciate that some other studies had one or more tumors, the NTP considers the concurrent control group as the most important comparator to the treated groups. We took the historical control tumor rates into account in a more subjective manner in our interpretation of the findings. In 2010, we asked to adopt more formal method of incorporating historical control data in our statistical testing, but our Board of Scientific Counselors voted against adopting the method.

It is puzzling why the control had short survival rate. Given that most of the gliomas and heart schwannomas are late-developing tumors, it is possible that if the controls were living longer some tumors might develop. Although the use of poly-3 (or poly-6) test intended to adjust the number of rats *used in the study, it is still important to re-evaluate the analysis by considering the incidence rate in controls not being 0. (Max Lee)*

We do not know why the male rat control group had a low survival rate. We generally d observe lower survival rates in studies such as the RFR studies in which animals are singly- rather than group housed. While some tumors might possibly have arisen in controls if they lived longer, it was notable that n glial cell or Schwann cell hyperplasias were found in these animals as well.

The poly-k (e.g., poly-3 or poly-6) test was developed to adjust for the fact that not all animals survive to the end of a two-year study, and survival rates may differ among groups. The test is essentially Cochran-Armitage trend test in which the denominator of the tumor rate in each group is adjusted downward to better reflect the number of animal-years at risk during the study. Each animal that develops the tumor or survives to the end of the study is counted as one animal. Each animal that does not develop the tumor and dies (or is moribund sacrificed) before the end of the study is counted as a fractional animal. The fraction is calculated as the proportion of the study that it survived, raised to the k-th power; = 3 or = 6 in this study. The survival-adjusted tumor rate in each group is then the number of animals having the tumor of interest divided by the total count of animals at risk of developing the tumor in the group. These survival-adjusted rates are used in the Cochran-Armitage formula to provide the poly-k test for dose-related trends and pairwise comparisons with the control group.

The poly-k test has been shown to yield valid inferences about tumor rates in NTP two-year rat and mouse carcinogenicity studies (Bailer and Portier, 1988; Portier and Bailer, 1989; Portier et al., 1986). Its theoretical basis is that tumor incidence, while not directly observed unless the tumor is immediately lethal, follows a Weibull distribution with a shape parameter, k. Verification using NTP studies has shown that if k is between 1 and 5, setting $k = 3$ yields a valid statistical test (Portier and Bailer, 1989; Portier et al, 1986). Thus, most of the time, the NTP uses the poly-3 test. If tumor type is late-occurring, as we observed with the brain gliomas, $k = 6$ is a better fit to the data and the poly-6 test has more validity.

In the portion of the text describing differences in survival at the end of the study between control and RFR-exposed animals the compared characteristic is not named an also n numerical values of the estimates or the range of differences are given. I would ad numbers in the text of a Appendix table showing the group survival estimates described in this paragraph. (Aleksandra M. Michalowski)

The Statistical Methods section describes the method for comparing survival distributions between the control and RFR-exposed groups, namely, Tarone's (1975) life table test to identify exposure-related trends in survival and Cox's (1972) method for testing two groups for equality of survival distributions.

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

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18-0161 Public Comment
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ADDITIONAL RESPONSE:

Dear All,

Thanks again for all your helpful comments on the NTP RFR studies. I did want to follow up on one remaining point of disagreement that Mike Lauer alluded to in his comments about low powered studies. Although we agree that our study design had low power to detect statistically significant neoplastic effects in the brain and heart, which occurred with both RFR modulations in male rats, we disagree over the assertion that low power in and of itself, creates false positive results. We cited a handful of publications outlining the statistical arguments against this with specific respect to the NTP rodent cancer study design in our response to comments document sent earlier. Although Mike referred to the example of positive findings in underpowered epidemiology studies that could not be replicated in larger follow up studies, there is a growing literature alluding to this problem with respect to experimental animal studies as well. An example is a relatively recent article by one of our collaborators in CAMARADES, Malcolm MacLeod.

http://www.nature.com/news/2011/110928/full/477511a.html

It's important to distinguish between low power to detect effects, and the constellation of other factors that often accompany low powered experimental animal studies in contributing to this problem. We've addressed this issue in a recent editorial, and these factors are captured in our published systematic review process for evaluating study quality in environmental health sciences (Rooney et al., 2014).

http://ehp.niehs.nih.gov/wp-content/uploads/122/7/ehp.1408671.pdf

http://ehp.niehs.nih.gov/wp-content/uploads/122/7/ehp.1307972.pdf

Table 1 in the Rooney et al. report outlines risk of bias considerations that commonly plague studies carried out by academic researchers that are accounted for in NTP studies.

I provide these examples to assure you that we are completely cognizant of these issues and take them very seriously. Again, we appreciate the help you've provided in assuring that we appropriately interpret and communicate our findings.

Best
John Bucher

EMF Health Effects

Is Cell Tower Radiation Dangerous?

Cell Phone Tower Exposure Overview

You are exposed to 100 million times more electromagnetic radiation than your grandparents were, and part of the reason is radiation from cell phone towers and microwave antennas.

Human population centers are flooded with massive amounts of powerful wireless microwave radiation. Cell phone towers emit high-frequency radio waves, or microwaves, that can travel as far as 45 miles over level terrain. The closer you are, the greater the danger.

Know Your EMF Health Risks

- Cell and Smart Phones
- Electrostress from Computers
- EMFs in the Home
- Electrostress and Travel
- Wi-Fi Router Dangers

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

The microwaves from cell phone towers can interfere with your body's own EMFs, causing a variety of potential health problems, including:

- Headaches
- Memory loss
- Cardiovascular stress
- Low sperm count
- Birth defects
- Cancer

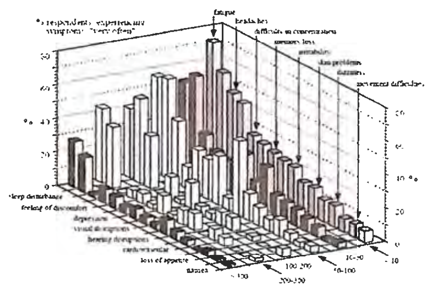

Figure 9. Response of residents living in the vicinity of a cellular phone base station in France.

A Closer Look at Cell Tower Exposure

Cell towers (or cell sites) that hold antennas and other communications equipment flood the area for miles around with powerful high frequency radio waves (known as microwaves) to support the use of cellphones as well as Wi-Fi, WiMax, Wireless LANs, 802.11 networks, Bluetooth supported devices and more.

Cell tower microwaves might travel for as few as two miles in hilly areas, and up to 45 miles where there are fewer obstructions; and of course, they easily penetrate brick and

EMFs from Underground Pipes

Smart Meters

Choose Products to Protect Yourself

SafeSpace Solutions

and billboards, typically installed 800-1300 feet apart.

Mobile towers - Sometimes installed on the tops of buildings. Mobile towers are especially dangerous because they emit microwaves at a frequency of 1900 MHz. Recent studies have shown that the intense radioactivity from mobile phone towers adversely impacts every biological organism within one square kilometer.

Cellphone tower microwaves have a significantly higher frequency than even radio waves. The higher the frequency, the more powerful the wave—and the more powerful effect on biological organisms (recall that a mobile tower emit microwaves at 1900 MHz).

Protecting Yourself and Your Family

Cell phone towers and power lines are virtually everywhere. However, SafeSpace offers a range of effective, affordable products that can help you protect yourself and your loved ones against the dangers from hallmarks of the modern world. For more information, **click here**.

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18-0161 Public Comment
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Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposures)

Draft 5-19-2016

Table of Contents

Abstract

The US National Toxicology Program (NTP) has carried out extensive rodent toxicology and carcinogenesis studies of radiofrequency radiation (RFR) at frequencies and modulations used in the US telecommunications industry. This report presents partial findings from these studies. The occurrences of two tumor types in male Harlan Sprague Dawley rats exposed to RFR, malignant gliomas in the brain and schwannomas of the heart, were considered of particular interest, and are the subject of this report. The findings in this report were reviewed by expert peer reviewers selected by the NTP and National Institutes of Health (NIH). These reviews and responses to comments are included as appendices to this report, and revisions to the current document have incorporated and addressed these comments. Supplemental information in the form of 4 additional manuscripts has or will soon be submitted for publication. These manuscripts describe in detail the designs and performance of the RFR exposure system, the dosimetry of RFR exposures in rats and mice, the results to a series of pilot studies establishing the ability of the animals to thermoregulate during RFR exposures, and studies of DNA damage.

Capstick M, Kuster N, Kühn S, Berdinas-Torres V, Wilson P, Ladbury J, Koepke G, McCormick D, Gauger J, Melnick R. A radio frequency radiation reverberation chamber exposure system for rodents

Yijian G, Capstick M, McCormick D, Gauger J, Horn T, Wilson P, Melnick RL and Kuster N. Life time dosimetric assessment for mice and rats exposed to cell phone radiation

Wyde ME, Horn TL, Capstick M, Ladbury J, Koepke G, Wilson P, Stout MD, Kuster N, Melnick R, Bucher JR, and McCormick D. Pilot studies of the National Toxicology Program's cell phone radiofrequency radiation reverberation chamber exposure system

Smith-Roe SL, Wyde ME, Stout MD, Winters J, Hobbs CA, Shepard KG, Green A, Kissling GE, Tice RR, Bucher JR, Witt KL. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure

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SUMMARY

The purpose of this communication is to report partial findings from a series of radiofrequency radiation (RFR) cancer studies in rats performed under the auspices of the U.S. National Toxicology Program (NTP).[1] This report contains peer-reviewed, neoplastic and hyperplastic findings only in the brain and heart of Hsd:Sprague Dawley® SD® (HSD) rats exposed to RFR starting *in utero* and continuing throughout their lifetimes. These studies found low incidences of malignant gliomas in the brain and schwannomas in the heart of male rats exposed to RFR of the two types [Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM)] currently used in U.S. wireless networks. Potentially preneoplastic lesions were also observed in the brain and heart of male rats exposed to RFR.

The review of partial study data in this report has been prompted by several factors. Given the widespread global usage of mobile communications among users of all ages, even a very small increase in the incidence of disease resulting from exposure to RFR could have broad implications for public health. There is a high level of public and media interest regarding the safety of cell phone RFR and the specific results of these NTP studies.

[1] NTP is a federal, interagency program, headquartered at the National Institute of Environmental Health Sciences, part of the National Institutes of Health, whose goal is to safeguard the public by identifying substances in the environment that may affect human health. For more information about NTP and its programs, visit http://ntp.niehs.nih.gov

Lastly, the tumors in the brain and heart observed at low incidence in male rats exposed to GSM- and CDMA-modulated cell phone RFR in this study are of a type similar to tumors observed in some epidemiology studies of cell phone use. These findings appear to support the International Agency for Research on Cancer (IARC) conclusions regarding the possible carcinogenic potential of RFR.[2]

It is important to note that this document reviews only the findings from the brain and heart and is not a complete report of all findings from the NTP's studies. Additional data from these studies in Hsd:Sprague Dawley® SD® (Harlan) rats and similar studies conducted in $B6C3F_1/N$ mice are currently under evaluation and will be reported together with the current findings in two forthcoming NTP Technical Reports.

STUDY RATIONALE

Cell phones and other commonly used wireless communication devices transmit information via non-ionizing radiofrequency radiation (RFR). In 2013, IARC classified RFR as a *possible human carcinogen* based on "limited evidence" of an association between exposure to RFR from heavy wireless phone use and glioma and acoustic neuroma (vestibular schwannoma) in human epidemiology studies, and "limited evidence" for the carcinogenicity of RFR in experimental animals. While ionizing radiation is a well-accepted human carcinogen, theoretical arguments have been raised against the possibility that non-ionizing radiation could induce tumors (discussed in IARC, 2013). Given the extremely large number of people who use wireless

[2] IARC (International Agency for Research on Cancer). 2013. Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. IARC Monogr Eval Carcinog Risk Hum 102. Available: http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf [accessed 26 May 2016].

communication devices, even a very small increase in the incidence of disease resulting from exposure to the RFR generated by those devices could have broad implications for public health.

DESCRIPTION OF THE NTP CELL PHONE RFR PROGRAM

RFR emitted by wireless communication devices, especially cell phones, was nominated to the NTP for toxicology and carcinogenicity testing by the U.S. Food and Drug Administration (FDA). After careful and extensive evaluation of the published literature and experimental efforts already underway at that time, the NTP concluded that additional studies were warranted to more clearly define any potential health hazard to the U.S. population. Due to the technical complexity of such studies, NTP staff worked closely with RFR experts from the National Institute of Standards and Technology (NIST). With support from NTP, engineers at NIST evaluated various types of RFR exposure systems and demonstrated the feasibility of using a specially designed exposure system (reverberation chambers), which resolved the inherent limitations identified in existing systems.

In general, NTP chronic toxicity/carcinogenicity studies expose laboratory rodents to a test article for up to 2 years and are designed to determine the potential for the agent tested to be hazardous and/or carcinogenic to humans.[3] For cell phone RFR, a program of study was designed to evaluate potential, long-term health effects of whole-body exposures. These studies were conducted in three phases: (1) a series of pilot studies to establish field strengths that do not raise body temperature, (2) 28-day toxicology studies in rodents exposed to various low-level field strengths, and (3) chronic toxicology and carcinogenicity studies. The studies were carried out under contract at IIT Research Institute (IITRI) in Chicago, IL following Good Laboratory

[3] Specifications for the Conduct of NTP Studies, http://ntp.niehs.nih.gov/ntp/test_info/finalntp_toxcarspecsjan2011.pdf

Practices (GLP). These studies were conducted in rats and mice using a reverberation chamber exposure system with two signal modulations [Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM)] at two frequencies (900 MHz for rats and 1900 MHz for mice), the modulations and frequency bands that are primarily used in the United States.

STUDY DESIGN

Hsd:Sprague Dawley® SD® (Harlan) rats were housed in custom-designed reverberation chambers and exposed to cell phone RFR. Experimentally generated 900 MHz RF fields with either GSM or CDMA modulation were continuously monitored in real-time during all exposure periods via RF sensors located in each exposure chamber that recorded RF field strength (V/m). Animal exposure levels are reported as whole-body specific absorption rate (SAR), a biological measure of exposure based on the deposition of RF energy into an absorbing organism or tissue. SAR is defined as the energy (watts) absorbed per mass of tissue (kilograms). Rats were exposed to GSM- or CDMA-modulated RFR at 900 MHz with whole-body SAR exposures of 0, 1.5, 3, or 6 W/kg. RFR field strengths were frequently adjusted based on changes in body weight to maintain desired SAR levels.

Exposures to RFR were initiated *in utero* beginning with the exposure of pregnant dams (approximately 11-14 weeks of age) on Gestation Day (GD) 5 and continuing throughout gestation. After birth, dams and pups were exposed in the same cage through weaning on postnatal day (PND) 21, at which point the dams were removed and exposure of 90 pups per sex per group was continued for up to 106 weeks. Pups remained group-housed from PND 21 until they were individually housed on PND 35. Control and treatment groups were populated with no more than 3 pups per sex per litter. All RF exposures were conducted over a period of approximately 18 hours using a continuous cycle of 10 minutes on (exposed) and 10 minutes off (not exposed), for a total daily exposure time of approximately 9 hours a day, 7 days/week. A single, common group of unexposed animals of each sex served as controls for both RFR modulations. These control rats were housed in identical reverberation chambers with no RF signal generation. Each chamber was maintained on a 12-hour light/dark cycle, within a temperature range of 72 ± 3°F, a humidity range of 50 ± 15%, and with at least 10 air changes per hour. Throughout the studies, all animals were provided *ad libitum* access to feed and water.

RESULTS

In pregnant rats exposed to 900 MHz GSM- or CDMA-modulated RFR, no exposure-related effects were observed on the percent of dams littering, litter size, or sex distribution of pups. Small, exposure-level-dependent reductions (up to 7%) in body weights compared to controls were observed throughout gestation and lactation in dams exposed to GSM- or CDMA-modulated RFR. In the offspring, litter weights tended to be lower (up to 9%) in GSM and CDMA RFR-exposed groups compared to controls. Early in the lactation phase, body weights of male and female pups were lower in the GSM-modulated (8%) and CDMA-modulated (15%) RFR groups at 6 W/kg compared to controls. These weight differences in the offspring for both GSM and CDMA exposures tended to lessen (6% and 10%, respectively) as lactation progressed. Throughout the remainder of the chronic study, no RFR exposure-related effects on body weights were observed in male and female rats exposed to RFR, regardless of modulation.

At the end of the 2-year study, survival was lower in the control group of males than in all groups of male rats exposed to GSM-modulated RFR. Survival was also slightly lower in control females than in females exposed to 1.5 or 6 W/kg GSM-modulated RFR. In rats exposed to CDMA-modulated RFR, survival was higher in all groups of exposed males and in the 6 W/kg females compared to controls.

Brain

A low incidence of malignant gliomas and glial cell hyperplasia was observed in all groups of male rats exposed to GSM-modulated RFR (Table 1). In males exposed to CDMA-modulated RFR, a low incidence of malignant gliomas occurred in rats exposed to 6 W/kg (Table 1). Glial cell hyperplasia was also observed in the 1.5 W/kg and 6 W/kg CDMA-modulated exposure groups. No malignant gliomas or glial cell hyperplasias were observed in controls. There was not a statistically significant difference between the incidences of lesions in exposed male rats compared to control males for any of the GSM- or CDMA-modulated RFR groups. However, there was a statistically significant positive trend in the incidence of malignant glioma ($p < 0.05$) for CDMA-modulated RFR exposures.

Table 1. Incidence of brain lesions in male Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated RFR[§]

	Control	GSM			CDMA		
	0 W/kg	1.5 W/kg	3 W/kg	6 W/kg	1.5 W/kg	3 W/kg	6 W/kg
Number examined	90	90	90	90	90	90	90
Malignant glioma [† ‡]	0[*]	3 (3.3%)	3 (3.3%)	2 (2.2%)	0	0	3 (3.3%)
Glial cell hyperplasia	0	2 (2.2%)	3 (3.3%)	1 (1.1%)	2 (2.2%)	0	2 (2.2%)

[§] Data presented as number of animals per group with lesions (percentage of animals per group with lesions).
[*] Significant SAR-dependent trend for CDMA exposures by poly-6 ($p < 0.05$). See appendix B
[†] Poly-6 survival adjusted rates for malignant gliomas were 0/53.48 in controls; GSM: 3/67.96 (4.4%), 3/72.10 (4.2%), and 2/72.65 (2.8%) in the 1.5, 3, and 6 W/kg groups, respectively; CDMA: 0/65.94, 0/73.08, and 3/57.49 (5.2%) for the 1.5, 3, and 6 W/kg groups, respectively.
[‡] Historical control incidence in NTP studies: 11/550 (2.0%), range 0-8%

In females exposed to GSM-modulated RFR, a malignant glioma was observed in a single rat exposed to 6 W/kg, and glial cell hyperplasia was observed in a single rat exposed to 3 W/kg (Table 2). In females exposed to CDMA-modulated RFR, malignant gliomas were observed in two rats exposed to 1.5 W/kg. Glial cell hyperplasia was observed in one female in each of the CDMA-modulation exposure groups (1.5, 3, and 6 W/kg). There was no glial cell hyperplasia or malignant glioma observed in any of the control females. Detailed descriptions of the malignant gliomas and glial cell hyperplasias are presented in Appendix C.

Table 2. Incidence of brain lesions in female Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated RFR[§]

	Control	GSM			CDMA		
	0 W/kg	1.5 W/kg	3 W/kg	6 W/kg	1.5 W/kg	3 W/kg	6 W/kg
Number examined	90	90	90	90	90	90	90
Malignant glioma [‡]	0	0	0	1 (1.1%)	2 (2.2%)	0	0
Glial cell hyperplasia	0	0	1 (1.1%)	0	1 (1.1%)	1 (1.1%)	1 (1.1%)

[§] Data presented as number of animals per group with lesions (percentage of animals per group with lesions).
[‡] Historical control incidence in NTP studies: 1/540 (0.18%), range 0-2%

Heart

Cardiac schwannomas were observed in male rats in all exposed groups of both GSM- and CDMA-modulated RFR, while none were observed in controls (Table 3). For both modulations (GSM and CDMA), there was a significant positive trend in the incidence of schwannomas of the heart with respect to exposure SAR. Additionally, the incidence of schwannomas in the 6 W/kg males was significantly higher in CDMA-modulated RFR-exposed males compared to controls. The incidence of schwannomas in the 6 W/kg GSM-modulated RFR-exposed males was higher, but not statistically significant ($p = 0.052$) compared to controls. Schwann cell hyperplasia of the heart was also observed in three males exposed to 6 W/kg CDMA-modulated RFR. In the GSM-modulation exposure groups, a single incidence of Schwann cell hyperplasia was observed in a 1.5 W/kg male.

Table 3. Incidence of heart lesions in male Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated cell phone RFR§

	Control	GSM			CDMA		
	0 W/kg	1.5 W/kg	3 W/kg	6 W/kg	1.5 W/kg	3 W/kg	6 W/kg
Number examined	90	90	90	90	90	90	90
Schwannoma †‡	0*	2 (2.2%)	1 (1.1%)	5 (5.5%)	2 (2.2%)	3 (3.3%)	6 (6.6%)**
Schwann cell hyperplasia	0	1 (1.1%)	0	2 (2.2%)	0	0	3 (3.3%)

§ Data presented as number of animals per group with lesions (percentage of animals per group with lesions).
* Significant SAR level-dependent trend for GSM and CDMA by poly-3 ($p < 0.05$). See appendix B
** Significantly higher than controls by poly-3 ($p < 0.05$)
† Poly-3 survival adjusted rates for schwannomas were 0/65.47 in controls; GSM: 2/74.87 (2.7%), 1/77.89 (1.3%), and 5/78.48 (6.4%) in the 1.5, 3, and 6 W/kg groups, respectively; CDMA: 2/74.05 (2.7%), 3/78.67 (3.8%), and 6/67.94 (8.8%) for the 1.5, 3, and 6 W/kg groups, respectively.
‡ Historical control incidence in NTP studies: 9/699 (1.3%) range 0-6%

In females, schwannomas of the heart were also observed at 3 W/kg GSM-modulated RFR and 1.5 and 6 W/kg CDMA-modulated RFR. Schwann cell hyperplasia was observed in one female in each of the CDMA-modulation exposure groups (1.5, 3, and 6 W/kg).

Table 4. Incidence of heart lesions in female Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated cell phone RFR§

	Control	GSM			CDMA		
	0 W/kg	1.5 W/kg	3 W/kg	6 W/kg	1.5 W/kg	3 W/kg	6 W/kg
Number examined	90	90	90	90	90	90	90
Schwannoma‡	0	0	2 (2.2%)	0	2 (2.2%)	0	2 (2.2%)
Schwann cell hyperplasia	0	0	0	0	1 (1.1%)	1 (1.1%)	1 (1.1%)

§ Data presented as number of animals per group with tumors (percentage of animals per group with tumors).
‡ Historical control incidence in NTP studies: 4/699 (0.6 %), range 0-4%

Schwann cells are present in the peripheral nervous system and are distributed throughout the whole body, not just in the heart. Therefore, organs other than the heart were examined for schwannomas and Schwann cell hyperplasia. Several occurrences of schwannomas were observed in the head, neck, and other sites throughout the body of control and GSM and CDMA RFR-exposed male rats. In contrast to the significant increase in the incidence of schwannomas in the heart of exposed males, the incidence of schwannomas observed in other tissue sites of exposed males (GSM and CDMA modulations) was not significantly different than in controls (Table 5). Additionally, Schwann cell hyperplasia was not observed in any tissues other than the heart. The combined incidence of schwannomas from all sites was generally higher in GSM- and CDMA-modulated RFR exposed males, but not significantly different than in controls. The Schwann cell response to RFR appears to be specific to the heart of male rats.

Table 5. Incidence of schwannomas in male Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated RFR§

	Control	GSM			CDMA		
	0 W/kg	1.5 W/kg	3 W/kg	6 W/kg	1.5 W/kg	3 W/kg	6 W/kg
Number examined	90	90	90	90	90	90	90
Heart‡	0*	2 (2.2%)	1 (1.1%)	5 (5.5%)	2 (2.2%)	3 (3.3%)	6 (6.6%)**
Other sites†	3 (3.3%)	1 (1.1%)	4 (4.4%)	2 (2.2%)	2 (2.2%)	1 (1.1%)	1 (1.1%)
All sites (total)	3 (3.3%)	3 (3.3%)	5 (5.5%)	7 (7.7%)	4 (4.4%)	4 (4.4%)	7 (7.7%)

§ Data presented as number of animals per group with tumors (percentage of animals per group with tumors).
* Significant SAR level-dependent trend for GSM and CDMA, poly 3 test ($p < 0.05$)
** Significantly higher than controls, poly-3 test ($p < 0.05$)
‡ Historical control incidence in NTP studies: 9/699 (1.3%), range 0-6%
† Mediastinum, thymus, and fat

In female rats, there was no statistically significant or apparent exposure-related effect on the incidence of schwannomas in the heart or the combined incidence in the heart or other sites (Table 6).

Table 6. Incidence of schwannomas in female Hsd:Sprague Dawley® SD® (Harlan) rats exposed to GSM- or CDMA-modulated RFR§

Schwannoma site	Control 0 W/kg	GSM 1.5 W/kg	GSM 3 W/kg	GSM 6 W/kg	CDMA 1.5 W/kg	CDMA 3 W/kg	CDMA 6 W/kg
Number examined	90	90	90	90	90	90	90
Heart‡	0	0	2 (2.2%)	0	2 (2.2%)	0	2 (2.2%)
Other sites†	4 (4.4%)	1 (1.1%)	3 (3.3%)	1 (1.1%)	0	2 (2.2%)	2 (2.2%)
All sites (total)	4 (4.4%)	1 (1.1%)	5 (5.5%)	2 (2.2%)	2 (2.2%)	2 (2.2%)	4 (4.4%)

§ Data presented as number of animals per group with tumors (percentage of animals per group with tumors).
‡ Historical control incidence in NTP studies: 4/699 (0.6%), range 0-4%
† Ovary, uterus, vagina, thymus, abdomen, and clitoral gland

DISCUSSION

The two tumor types, which are the focus of this report, are malignant gliomas of the brain and schwannomas of the heart. Glial cells are a collection of specialized, non-neuronal, support cells whose functions include maintenance of homeostasis, formation of myelin, and providing support and protection for neurons of the peripheral nervous system (PNS) and the central nervous system (CNS). In the CNS, glial cells include astrocytes, oligodendrogliocytes, microglial cells, and ependymal cells. Schwann cells are classified as glial cells of the PNS. In the PNS, Schwann cells produce myelin and are analogous to oligodendrocytes of the CNS. Generally, glial neoplasms in the rat are aggressive, poorly differentiated, and usually classified as malignant.

In the heart, exposure to GSM or CDMA modulations of RFR in male rats resulted in a statistically significant, positive trend in the incidence of schwannomas. There was also a statistically significant, pairwise increase at the highest CDMA exposure level tested compared to controls. Schwann cell hyperplasias also occurred at the highest exposure level of CDMA-modulated RFR. Schwann cell hyperplasia in the heart may progress to cardiac schwannomas. No Schwann cell hyperplasias or schwannomas of the heart were observed in the single, common control group of male rats. The historical control rate of schwannomas of the heart in male Harlan Sprague Dawley rats is 1.30% (7/539) and ranges from 0-6% for individual NTP studies (Table D2, Appendix D). The 5.5-6.6% observed in the 6 W/kg GSM- and CDMA-modulated RFR groups exceeds the historical incidence, and approaches or exceeds the highest rate observed in a single study (6%). The increase in the incidence of schwannomas in the heart of male rats in this study is likely the result of whole-body exposures to GSM- or CDMA-modulated RFR.

In the brain, there was a significant, positive trend in the incidences of malignant gliomas in males exposed to CDMA-modulated RFR, and a low incidence was observed in males at all exposure levels of GSM-modulated RFR that was not statistically different than in control males. Glial cell hyperplasia, a preneoplastic lesion distinctly different from gliosis, was also observed at low incidences in rats exposed to either GSM or CDMA modulation. Glial cell hyperplasia may progress to malignant glioma. Neither of these lesions was observed in the control group of male rats. Although not observed in the current control group, malignant gliomas have been observed in control male Harlan Sprague Dawley rats from other completed NTP studies. Currently in males, the historical control rate of malignant glioma for those studies is 2.0% (11/550) and ranges from 0-8% for individual studies (Table D1, Appendix D). The 2.2-3.3% observed in all of the GSM-modulation groups and in the 6 W/kg CDMA-modulated group only slightly exceeds the mean historical control rate and falls within the observed range.

The survival of the control group of male rats in the current study (28%) was relatively low compared to other recent NTP studies in Hsd:Sprague Dawley® SD® (Harlan) rats (average 47%, range 24-72%). If malignant gliomas or schwannomas are late-developing tumors, the absence of these lesions in control males in the current study could conceivably be related to the shorter longevity of control rats in this study. Appendix E lists the time on study for each animal with a malignant glioma or heart schwannoma. Most of the gliomas were observed in animals that died late in the study, or at the terminal sacrifice. However, a relatively high number of the heart schwannomas in exposed groups were observed by 90 weeks into the study, a time when approximately 60 of the 90 control male rats remained alive and at risk for developing a tumor.

CONCLUSIONS

Under the conditions of these 2-year studies, the hyperplastic lesions and glial cell neoplasms of the heart and brain observed in male rats are considered likely the result of whole-body exposures to GSM- or CDMA-modulated RFR. There is higher confidence in the association between RFR exposure and the neoplastic lesions in the heart than in the brain. No biologically significant effects were observed in the brain or heart of female rats regardless of modulation.

NEXT STEPS

The results reported here are limited to select findings of concern in the brain and heart and do not represent a complete reporting of all findings from these studies of cell phone RFR. The complete results for all NTP studies on the toxicity and carcinogenicity of GSM and CDMA-modulated RFR are currently being reviewed and evaluated according to the established NTP process and will be reported together with the current findings in two forthcoming NTP

Technical Reports. Given the large scale and scope of these studies, completion of this process is anticipated by fall 2017, and the draft NTP Technical Reports are expected to be available for peer review and public comment by the end of 2017. We anticipate that the results from a series of initial studies investigating the tolerance to various power levels of RFR, including measurements of body temperatures in both sexes of young and old rats and mice and in pregnant female rats, will be published in the peer-reviewed literature later in 2016.

APPENDIX A – CONTRIBUTORS

NTP CONTRIBUTORS

Participated in the evaluation and interpretation of results and the reporting of findings.

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APPENDIX B – STATISTICAL ANALYSIS

The Poly-k test (Bailer and Portier, 1988; Portier and Bailer, 1989; Piegorsch and Bailer, 1997) was used to assess neoplasm prevalence. This test is a survival-adjusted quantal-response procedure that modifies the Cochran-Armitage linear trend test to take survival differences into account. More specifically, this method modifies the denominator in the quantal estimate of lesion incidence to approximate more closely the total number of animal years at risk. For analysis of lesion incidence at a given site, each animal is assigned a risk weight. This value is one if the animal had a lesion at that site or if it survived until terminal sacrifice; if the animal died prior to terminal sacrifice and did not have a lesion at that site, its risk weight is the fraction of the entire study time that it survived, raised to the kth power. This method yields a lesion prevalence rate that depends only upon the choice of a shape parameter, k, for a Weibull hazard function describing cumulative lesion incidence over time (Bailer and Portier, 1988). A further advantage of the Poly-k method is that it does not require lesion lethality assumptions.

Unless otherwise specified, the NTP uses a value of k=3 in the analysis of site-specific lesions (Portier et al., 1986). Bailer and Portier (1988) showed that the Poly-3 test gives valid results if the true value of k is anywhere in the range from 1 to 5. In addition, Portier et al. (1986) modeled a collection of relatively common tumors observed in control animals from two-year NTP rodent carcinogenicity studies, showing that the Weibull distribution with values of k ranging between 1 and 5 was a reasonable fit to tumor incidence in most cases. In cases of early tumor onset or late tumor onset, however, k=3 may not be the optimal choice. Tumors with early onset would require a value of k much less than 3, while tumors with late onset would require a value of k much greater than 3. In the current studies, malignant brain gliomas occurred only in animals surviving more than 88% of the length of the study. For these brain tumors, a Weibull distribution with k=6 is a better fit to survival time than with k=3 (Portier, 1986). Malignant schwannomas of the heart occurred in animals surviving at least 65% of the length of the study; a Weibull distribution with k=3 adequately fits these heart tumor incidences. Therefore, poly-6 tests were used for analyses of brain tumors and poly-3 tests were used for schwannomas.

Variation introduced by the use of risk weights, which reflect differential mortality, was accommodated by adjusting the variance of the Poly-k statistic as recommended by Bieler and Williams (1993) and a continuity correction modified from Thomas et al. (1977) was applied.

Tests of significance for tumors and nonneoplastic lesions included pairwise comparisons of each dosed group with controls and a test for an overall dose-related trend. Continuity-corrected Poly-k tests were used in the analysis of lesion incidence, and reported P values are one sided.

Body weights and litter weights were compared to the control group using analysis of variance and Dunnett's test (1955). The probability of survival was estimated by the product-limit procedure of Kaplan and Meier (1958). Statistical analyses for possible exposure-related effects on survival used Cox's (1972) method for testing two groups for equality and Tarone's (1975) life table test to identify exposure-related trends. Survival analysis p-values are two-sided.

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APPENDIX C – PATHOLOGY

Pathology data presented in this report on cell phone RFR were subjected to a rigorous peer review process. The primary goal of the NTP peer-review process is to reach consensus agreement on treatment-related findings, confirm the diagnosis of all neoplasms, and confirm any unusual lesions. At study termination, a complete necropsy and histopathology evaluation was conducted on every animal. The initial pathology examination was performed by a veterinary pathologist, who recorded all neoplastic and nonneoplastic lesions. This examination identified several potential treatment-related lesions in target organs of concern (brain and heart), which were chosen for immediate review.[1] The initial findings of glial cell tumors and hyperplasias in the brain and schwannomas, Schwann call hyperplasia, and schwannomas from all sites were subjected to an expedited, multilevel NTP pathology peer-review process. The data were locked[2] prior to receipt of the finalized, study-laboratory reports to ensure that the raw data did not change during the review.

The pathology peer review consisted of a quality assessment (QA) review of all slides with tissues from the central nervous system (7 sections of brain and 3 sections of spinal cord), trigeminal nerve and ganglion, and heart. Additionally, the schwannomas of the head and neck region were reviewed. The QA review of the central nervous system and head and neck schwannomas was performed by Dr. Margarita Gruebbel of Experimental Pathology Laboratories, Inc. (EPL), and the QA review of the hearts and trigeminal nerves and ganglia was performed by Dr. Cynthia Shackelford, EPL.

The QA review pathologists then met with Dr. Mark Cesta, NTP pathologist for these studies, and Dr. David Malarkey, head of the NTP Pathology Group, to review lesions and select slides for the Pathology Working Group (PWG) reviews. All PWG reviews were conducted blinded with respect to treatment group and only identified the test articles as "test agent A" or "test

[1] Pathology peer review of remaining lesions from the cell phone RFR studies continues and is not addressed in this report.
[2] Locking data refers to restricting access to the computer database so the data for a particular study cannot be changed.

agent B". Due to the large number of slides for review, the PWG was held in three separate sessions:

- January 29, 2016, for review of glial lesions in the brain and Schwann cell lesions in the heart
- February 11, 2016, for review of schwannomas of the head and neck
- February 12, 2016, for review of granular cell lesions of the brain

The reviewing PWG pathologists largely agreed on the diagnostic criteria for the lesions and on the diagnoses of schwannomas in the head and neck, and granular cell lesions in the brain. However, there was much discussion on the criteria for differentiating glial cell hyperplasia from malignant glioma and Schwann cell hyperplasia from schwannoma. The lack of PWG agreement on definitive criteria for the glial cell and Schwann cell lesions, and the requirement for a high level of confidence in the diagnoses prompted NTP to convene two additional PWGs (organized and conducted by the NTP pathologist, Dr. Mark Cesta) with selected experts in the organ under review. These second level PWG reviews were also conducted as noted above and held in two separate sessions:

- February 25, 2016, for review of glial lesions in the brain
- March 3, 2016, for review of cardiac schwannomas, schwannomas in other organs (except the head and neck), and right ventricular degeneration

In both PWGs, the participants came to consensus on the diagnoses of the lesions and the criteria used for those diagnoses. Participants of the individual PWGs are listed below.

Table C-1. NTP Pathology Working Group (PWG) Attendees

PWG member	Affiliation
January 29, 2016 - Evaluated glial lesions in the brain and Schwann cell lesions in the heart	
A.E. Brix, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC
M.F. Cesta, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (NTP study pathologist)
S.A. Elmore, D.V.M., MS	National Institute of Environmental Health Sciences
G.P. Flake, M.D.	National Institute of Environmental Health Sciences
R.H. Garman, D.V.M.	Consultants in Veterinary Pathology, Inc. Monroeville, PA
M.M. Gruebbel, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC (observer)
R.A. Herbert, D.V.M., Ph.D.	National Institute of Environmental Health Sciences
J.S. Hoane, D.V.M.	Charles River Laboratories, Inc. Durham, NC (contract study pathologist)
K.S. Janardhan, BVSc, MVSc, Ph.D.	Integrated Laboratory System
R. Kovi, BVSc, MVSc, Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC (observer)
D.E. Malarkey, D.V.M., Ph.D.	National Institute of Environmental Health Sciences
R.A. Miller, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC
J.P. Morrison, D.V.M.	Charles River Laboratories, Inc. Durham, NC

PWG member	Affiliation
A.R. Pandiri, BVSc & AH, Ph.D.	National Institute of Environmental Health Sciences
C.C. Shackelford, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC (observer)
J.A. Swenberg, D.V.M., Ph.D.	University of North Carolina – Chapel Hill, NC
G. Willson, BVMS, Dip RC Path, FRC Path, MRCVS	Experimental Pathology Laboratories, Inc. RTP, NC (PWG coordinator)
February 11, 2016 - Evaluated schwannomas of the head and neck	
A.E. Brix, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC
M.F. Cesta, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (NTP study pathologist)
S.A. Elmore, D.V.M., MS	National Institute of Environmental Health Sciences
G.P. Flake, M.D.	National Institute of Environmental Health Sciences
M.M. Gruebbel, D.V.M., Ph.D.,	Experimental Pathology Laboratories, Inc. RTP, NC (PWG coordinator)
K.S. Janardhan, BVSc, MVSc, Ph.D.	Integrated Laboratory System RTP, NC
D.E. Malarkey, D.V.M., Ph.D.	National Institute of Environmental Health Sciences
A.R. Pandiri, BVSc & AH, Ph.D.	National Institute of Environmental Health Sciences
R.R. Maronpot, D.V.M.	Experimental Pathology Laboratories, Inc. RTP, NC
February 12, 2016 - Evaluated granular cell lesions of the brain	
A.E. Brix, D.V.M., Ph.D.	Experimental Pathology Laboratories, Inc. RTP, NC
M.F. Cesta, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (NTP study pathologist)
S.A. Elmore, D.V.M., MS	National Institute of Environmental Health Sciences
M.M. Gruebbel, D.V.M., Ph.D.,	Experimental Pathology Laboratories, Inc. RTP, NC (PWG coordinator)
J.S. Hoane, D.V.M.	Charles River Laboratories, Inc. Durham, NC (contract study pathologist)
K.S. Janardhan, BVSc, MVSc, Ph.D.	Integrated Laboratory System RTP, NC
A.R. Pandiri, BVSc. & AH, Ph.D.	National Institute of Environmental Health Sciences
R.R. Moore, D.V.M.	Integrated Laboratory System RTP, NC
February 25, 2016 - Evaluated glial lesions in the brain	
D. Bigner, M.D., Ph.D.	Duke University Durham, NC
B. Bolon, D.V.M., MS, Ph.D.	GEMpath, Inc. Longmont, CO
V. Chen, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (observer)
M.F. Cesta, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (PWG coordinator, NTP study pathologist)
S.A. Elmore, D.V.M., MS	National Institute of Environmental Health Sciences (observer)
G.P. Flake, M.D.	National Institute of Environmental Health Sciences (observer)
J.S. Hardisty, D.V.M.	Experimental Pathology Laboratories, Inc. RTP, NC
R.A. Herbert, D.V.M., Ph.D.,	National Institute of Environmental Health Sciences (observer)
R. Kovi, BVSc, MVSc, Ph.D.	Experimental Pathology Laboratories, Inc. (observer)
P.B. Little, D.V.M.	Experimental Pathology Laboratories, Inc.
D.E. Malarkey, D.V.M., Ph.D.	National Institute of Environmental Health Sciences
J.P. Morrison, D.V.M., Ph.D.	Charles River Laboratories, Inc.
A. Sharma, BVSc, MVSc, MS, Ph.D.	Covance
March 3, 2016 - Evaluated heart lesions, and schwannomas in other organs (except head and neck)	
B. Berridge, D.V.M., Ph.D.	GlaxoSmithKline RTP, NC
M.C. Boyle, D.V.M., Ph.D.	Amgen Thousand Oaks, CA
V. Chen, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (observer)
M.F. Cesta, D.V.M., Ph.D.	National Institute of Environmental Health Sciences (PWG coordinator, NTP study pathologist)
S.A. Elmore, D.V.M., MS	National Institute of Environmental Health Sciences (observer)
M. Elwell, D.V.M., Ph.D.	Covance Chantilly, VA

PWG member	Affiliation
J.R. Hailey, D.V.M.	Covance Chantilly, VA
M. Novilla, D.V.M., MS, Ph.D.	SNBL Everett, WA

LESION DESCRIPTIONS

Brain

Malignant gliomas were infiltrative lesions, usually of modest size, with indistinct tumor margins. The neoplastic cells were typically very densely packed with more cells than neuropil. The cells were typically small and had round to oval, hyperchromatic nuclei. Mitoses were infrequent. In some of the neoplasms, invasion of the meninges, areas of necrosis surrounded by palisading neoplastic cells, cuffing of blood vessels, and neuronal satellitosis were observed. The malignant gliomas did not appear to arise from any specific anatomic subsite of the brain.

Glial cell hyperplasia consisted of small, proliferative, and poorly demarcated foci of poorly differentiated glial cells that accumulated and invaded into the surrounding parenchyma. In some cases, there was a small amount of perivascular cuffing. The hyperplastic cells appeared morphologically identical to those in the gliomas but were typically less dense with more neuropil than glial cells. There were no necrotic or degenerative elements present, so there was no evidence that the increased number of glial cells was a reaction to brain injury.

Heart

The intracardiac schwannomas were either endocardial or myocardial (intramural). The endocardial schwannomas lined the ventricles and atria and invaded into the myocardium. Two morphologic cell types were observed, but indistinct cell margins and eosinophilic cytoplasm were common to both types. Groups of cells with widely spaced small, round nuclei and moderate amounts of cytoplasm were interspersed among bands or sheets of parallel, elongated cells with thin, spindle-shaped, hyperchromatic nuclei. The myocardial schwannomas were typically less densely cellular and infiltrated amid, sometimes replacing, the cardiomyocytes. The cell types described for the endocardial neoplasms were both present, but in fewer numbers. In both subtypes of schwannomas, there was a minimal amount of cellular pleomorphism. In some larger neoplasms, Antoni type A and B patterns were present.

The Schwann cell hyperplasias were similar in appearance to the schwannomas, but were smaller and had less pleomorphism of the cells. In the case of the endocardial Schwann cell hyperplasia, there was no invasion of the myocardium.

APPENDIX D – HISTORICAL CONTROLS

Table D1. Incidence of astrocytoma, glioma, and/or oligodendroglioma in brains of male Harlan Sprague Dawley rats in NTP studies

Chemical	First dose	N	Control incidence
Dibutylphthalate	8/30/2010	49	4%
2-Hydroxy-4-methoxybenzophenone	11/8/2010	50	0%
p-Chloro-a,a,a-trifluorotoluene	1/17/2011	50	4%
Di-(2-ethylhexyl)phthalate	2/17/2011	50	8%
Di-(2-ethylhexyl)phthalate (perinatal)	6/27/2011	50	0%
Tris (chloroisopropyl) phosphate	12/12/2011	50	0%
Sodium tungstate	12/23/2011	50	4%
Resveratrol	5/7/2012	50	0%
Black cohosh	7/2/2012	50	2%
Radiofrequency radiation (GSM/CDMA)	9/16/2012	90	0%

Historical control rate: 11/550 (2.0%)

Table D2. Incidence of schwannoma in the heart of male Harlan Sprague Dawley rats in NTP studies

Chemical	First dose	N	Control incidence
Indole-3-carbinol	3/14/2007	50	2%
Perfluorooctanoic acid	6/19/2009	50	0%
Dietary zinc	9/3/2009	50	0%
Dibutylphthalate	8/30/2010	49	4%
2-Hydroxy-4-methoxybenzophenone	11/8/2010	50	2%
p-Chloro-a,a,a-trifluorotoluene	1/17/2011	50	0%
Di-(2-ethylhexyl)phthalate	2/17/2011	50	6%
Di-(2-ethylhexyl)phthalate (perinatal)	6/27/2011	50	4%
Tris (chloroisopropyl) phosphate	12/12/2011	50	0%
Sodium tungstate	12/23/2011	50	0%
Resveratrol	5/7/2012	50	0%
Black Cohosh	7/2/2012	50	0%
Radiofrequency radiation (GSM/CDMA)	9/16/2012	90	0%

Historical control rate: 9/699 (1.30%)

APPENDIX E – TIME ON STUDY TO APPEARANCE OF TUMORS

Malignant Glioma

SAR (W/kg)	Animal ID number	Time on study (weeks)
GSM-modulated exposed males		
1.5	717	105
	735	102
	786	104
3.0	924	101
	943	105
	1014	93
6.0	1135	104
	1137	102
CDMA-modulated exposed males		
6.0	1795	105
	1799	104
	1852	105
GSM-modulated exposed females		
6.0	1246	96
CDMA-modulated exposed females		
1.5	1463	105
	1474	105

Time to Malignant Schwannoma in Heart

SAR (W/kg)	Animal ID number	Length of survival (weeks)
GSM-modulated exposed males		
1.5	758	104
	801	105
3.0	931	105
6.0	1149	83
	1155	105
	1187	104
	1206	104
	1230	91
CDMA-modulated exposed males		
1.5	1364	105
	1352	105
3.0	1559	92
	1617	105
	1622	104
6.0	1801	76
	1821	70
	1829	104
	1833	89
	1849	104
	1860	105
GSM-modulated exposed females		
3.0	1037	105
	1077	83
CDMA-modulated exposed females		
1.5	1461	106
	1480	93
6.0	1888	105
	1965	106

APPENDIX F – REVIEWER'S COMMENTS

National Toxicology Program

Peer Review Charge and Summary Comments

Purpose: To provide independent peer review of an initial draft of this partial report. The peer reviewers were blind to the test agents under study. Introductory materials on RFR and details of the methods dealing with the field generation and animal housing were redacted from the version sent to the reviewers. The reviewers were provided a study data package, also blinded to test agents, containing basic in life study information such as body weight and survival curves and information concerning the generation of pups from the *in utero* exposures.

Report Title: Draft Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Test Articles A and B (and associated Study Data Package)

Reviewers' Names:

David Dorman, D.V.M., Ph.D., North Carolina State University
Russell Cattley, D.V.M., Ph.D., Auburn University
Michael Pino, D.V.M., Ph.D., Pathology consultant

Charge: To peer review the draft report and comment on whether the scientific evidence supports NTP's conclusion(s) for the study findings.

1. Scientific criticisms:
   a. Please comment on whether the information presented in the draft report, including presentation of data in any tables, is clearly and objectively presented. Please suggest any improvements.

      All three reviewers found the results to be clearly and objectively presented, although there were suggestions to provide historical control information for brain and heart lesions for female Harlan Sprague Dawley rats, clarify statements about the specific statistical tests used and the presence or lack of statistical significance of the brain gliomas in the Results, and expand the conclusions statements to clarify the basis for the conclusions.

b. Please comment on whether NTP's scientific interpretations of the data are objective and reasonable. Please explain why or why not.

The reviewers stated that the NTP had performed an adequate and objective peer review of the pathology data, and the statistical approaches used were consistent with other NTP studies. The methods were described as objective and reasonable. The interpretations of the data, including the limitations, were also reasonable and objective. One reviewer found the data on schwannomas of the heart to be more compelling with respect to an association with treatment than the brain gliomas. This reviewer summarized the findings as:

> "In the heart the evidence for a carcinogenic effect can be based on 1) the presence of the tumors in all six of the test article groups versus none in the controls 2) the statistically significant trend for schwannomas with both compounds and the statistically significant increase in incidence in the 4X (top) dose for test article B; 3) the fact that the incidence of the tumors in both 4X dose groups approaches or exceeds the high end of the historical control range; and 4) the tumors in the 4X group of test article B are accompanied by a higher incidence of Schwann cell hyperplasia. Using the NTP's guide for levels of evidence for carcinogenic activity, I would consider the heart schwannomas as 'Some Evidence' of carcinogenic activity.
>
> The proliferative lesions in the brain are more difficult to interpret because 1) their low incidence that was well within the historical control range, 2) lack of clear dose response; and 3) lack of statistical significance (except for the significant exposure-dependent trend for test article B. . . . However, the presence of malignant gliomas and/or foci of glial cell hyperplasia in 5 of 6 test article groups for both sexes vs none in controls of either sex is suggestive of a test

> article effect. . . .I would consider the malignant gliomas as 'Equivocal Evidence' of carcinogenic activity."

2. Please identify any Information that should be added or deleted:

One reviewer suggested that more information be given on the time when tumors were observed (e.g., at terminal necropsy, or early in the study) to help assess the possible impact of the decreased survival times in the control animals on tumor incidence. This reviewer also suggested a discussion of how the survival of control male rats in this study compared to the historical control data. There was also concern that the diagnostic criteria developed by the PWG and used in the current study would impact the historical control incidence rates reported in Table D.

3. The scientific evidence supports NTP's conclusion(s) for the study findings:

The NTP's overall draft conclusion was as follows: "Under the conditions of these studies, the observed hyperplastic lesions and neoplasms outlined in this partial report are considered likely the result of exposures to test article A and test article B. The findings in the heart were statistically stronger than the findings in the brain."

The reviewers had the option of agreeing, agreeing in principle, or disagreeing with the draft conclusions. All three reviewers agreed in principle, reiterating issues discussed above.

APPENDIX G – NIH REVIEWER'S COMMENTS

National Institutes of Health

Peer Review Charge and Reviewer's Comments

Purpose: To provide independent peer review of the pathology diagnoses and statistical evaluation of the partial findings from NTP's studies. Background materials included the draft NTP report, introductory materials on RFR, and details on the methods dealing with the field generation and statistical analyses references and guidance. The reviewers were provided a study data package, containing basic in life study information such as body weight and survival curves, information concerning the generation of pups from the *in utero* exposures, and raw pathology data.

Report Title: Draft Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Test Articles A and B (and associated Study Data Package)

Reviewers' Names:

Diana C. Haines, D.V.M., Frederick National Laboratory
Michael S. Lauer, M.D., Office of Extramural Research, NIH
Maxwell P. Lee, Ph.D., Laboratory of Cancer Biology and Genetics, NCI,
Aleksandra M. Michalowski, M.Sc., Ph.D., Laboratory of Cancer Biology and Genetics, NCI
R. Mark Simpson, D.V.M., Ph.D., Laboratory of Cancer Biology and Genetics, NCI
[Sixth reviewer's name and comments are withheld.]

Charge: To peer review the draft report, statistical analyses, and pathology data and comment on whether the scientific evidence supports NTP's conclusion(s) for the study findings.

Reviewer's comments and NTP responses to the comments are provided.

- Appendix G1: Reviewer's comments
- Appendix G2: NTP's responses to NIH reviewer's comments

Appendix G1: Reviewer's comments

Reviewer: Diana C. Haines, D.V.M., Frederick National Laboratory

April 5, 2016

Dr. Tabak,

I've always relied on experts, not myself, for statistical analysis, and so do not feel qualified to address the statistical methods used. My training and experience has been in veterinary pathology, including QA review of NTP studies, and serving on PWGs, so will give my opinion on the pathology interpretation (biological significance rather than statistical significance).

Having perused the 3 RFR Draft Report and the raw data, all appears to be in order, including QA of the histopathology (technique) as well as PWG review (diagnosis). Looking at the data, I agree with the report's conclusion: *Under the conditions of these studies, the hyperplastic lesions and neoplasms observed in male rats are considered likely the result of exposures to GSM- an CDMA-modulated RFR. The findings in the heart were statistically stronger than the findings in the brain.* But note, it is "considered likely" not "definitely is".

There may be also several caveats relating to "under the conditions of these studies", including how well the conditions recapitulate actual human exposure: whole body exposure from in utero to old age; 18.5 hours/day (10 min on/10 min off, for total of 9hr actual exposure); and dose[A]. I'm not physicist, so have to presume experts analyzed and accepted concept of the reverberation chamber, including "doses"[A] as being relevant to human exposure.

[A] Dosimetric Assessment paper: "As could be expected in a study following NTP protocols, the exposure levels for the rodents in this project exceed the limits for the wbSAR and psSAR defined in the IEEE Std C95.1-2005 safety standard for human exposure to mobile phone radiation. In the low dose exposure group the exposure level in the organs exceeds or is close to the localized SAR limit for the general public, except for a few low-water content tissues. More specifically, the psSAR over 1 g in the human head, is limited by the safety standards to <2W/kg, whereas, in the low dose rodents the SAR averaged over the whole brain is >2.4 W/kg for mice, and >1.3 W/kg for rats, hence similar to the limit. Furthermore, the psSAR and oSAR have larger uncertainty compared to the wbSAR. Deviations of the exposure level from the target dose, especially during the early exposure period, should be carefully evaluated in the interpretation of the final biological studies.

Results from the companion mouse study will hopefully add some insight.

Diana Copeland Haines, DVM
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Appendix G1: Reviewer's comments

Reviewer: Michael S. Lauer, M.D., Office of Extramural Research, NIH

Michael S Lauer, MD (OER)
Review of NTP paper: "Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation (Whole Body Exposures)"
March 20, 2016

Summary of findings:

This is a partial report, a report which is presumably part of a larger set of studies involving 2 species (mice and rats), 2 sexes (male, female), and multiple tissue types, all based on 90-week studies of two different types (GSM and CDMA) of cell phone radiofrequency radiation (RFR). In this partial report, we are given findings regarding brain gliomas and heart schwannomas in male and female Harlan Sprague Dawley rats which were exposed exposed to control or 3 different levels (1.5, 3.0, 6.0) of two types (GSM and CDMA) of RFR. There were 90 rats in each group. Using the poly-3 test with the Bieler-Williams variance adjustment, the authors found a statistically significant increase in the rate of brain gliomas in males exposed to CDMA RFR. Using the poly-6 test, the authors found a statistically significant increase in the rates of heart schwannomas in males exposed to GSM and CDMA. There were no statistically significant differences in rates of gliomas or schwannomas in females; also there was no statistically significant increase in rates of gliomas in males exposed to GSM RFR.

Comments:

1) Why aren't we being told, at least at a high level, of the results of other experiments (i.e., male and female mice, tissues other than heart and brain, tumors other than glioma and schwannoma)? Given the multiple comparisons inherent in this kind of work (see pages 27-30 and Table 13 of the FDA guidance document), there is a high risk of false positive discoveries. In the absence of knowing other findings, we must worry about selective reporting bias.
2) I was able to reproduce the authors' positive P-value findings (see Appendix 1, R code) using the MCPAN R package. However, I'm getting slightly different values for adjusted denominators (also in Appendix 1).
3) I was able to reproduce the authors' findings of longer survival with RFR (see Appendix 1, R code).
4) I have a number of questions about the study design:
    a. Were control rats selected in utero like the exposed rats were?
    b. Were pregnant dams assigned to different groups by formal randomization? If not, why not?
    c. Why were pups in the same litter included? Did the authors take any steps in their analyses to account for the resulting absence of i.i.d?
    d. The authors state that at most 3 pups were chosen per litter. How were the 3 pups chosen (and the others presumably not used for this experiment)? Were the 3 pups that were chosen selected by formal randomization? If not, why not?

e. Were all analyses based on the intent-to-treat principle? Were there any crossovers? Were all rats accounted for by the end of the experiment and were all rats who started in the experiment included in the final analyses?
f. Blinding: The authors state that "All PWG reviewer were conducted blinded with respect to treatment group," but in the very next phrase write "only identifying the test articles as 'test agent A' or 'test agent B.'" Why was this information (test agent A or B) given? The blinding was not complete.

5) Sample size:
   a. Did the authors perform a prospective (that is before initiation of the work) sample size calculation? If so, what were the prior assumptions? In other words, why did the authors choose to study 90 rats in each group and why did they set the maximum duration to 90 weeks (instead of 104 weeks)?
   b. I used a publicly available simulation package[1] to calculate the study power for male rats based on the following (see Appendix 2, power calculation simulation studies):
      i. Control tumor rate of ~1.5%.
      ii. Risk ratio 2.5 in the group receiving the highest dose
      iii. 2-sided Alpha = 0.005 (based on Table 13 of the FDA guidance document). Note this low alpha of 0.005 for poly-k trend tests is recommended to minimize the risk of false positive discoveries.
      iv. Sample size of 90 for each group with one planned sacrifice.
      v. Low lethality with lethality parameters set according to study duration and Weibull shape parameter (see Table 3 of Moon et al[1]). When I re-ran the simulations using intermediate lethality, results were not materially changed.
      vi. Study duration 90 weeks
      vii. 5000 simulations
      viii. Note – I used dose levels of 0,1,2, and 4 because I was unable to adjust these on the web site (despite trying 3 different browsers).
   c. Based on these inputs, the recommendations in Table 13 of the FDA guidance document, and a sample size of 90 rats in each group, I find very low power (<5%, see Appendix 2). Even allowing for a risk ratio of 5.0 (a level that is clinically unlikely), the power for 2-sided alpha=0.005, k=3 and low lethality is only ~14% (see Appendix 2).
   d. The low power implies that there is a high risk of false positive findings[2], especially since the epidemiological literature questions the purported association between cell phone exposure and cancer.[3]
6) Summary: I am unable to accept the authors' conclusions:
   a. We need to know all other findings of these experiments (mice, other tumor types) given the risk of false positive findings and reporting bias. It would be helpful to have a copy of the authors' statistical code.
   b. We need to know whether randomization was employed to assign dams to specific groups (control and intervention).

c. We need to know whether randomization was employed to determine which pups from each litter were chosen for continued participation in the experiment.
d. We need to know whether there was a formal power/sample size calculation performed prior to initiation of the experiment. If not, why not? If yes, we need to see the details. In particular, we need to know whether the authors followed the recommendations of the FDA guidance document (in particular Table 13).
e. I suspect that this experiment is substantially underpowered and that the few positive results found reflect false positive findings.[2] The higher survival with RFR, along with the prior epidemiological literature, leaves me even more skeptical of the authors' claims.

References:

1. Moon H, Lee JJ, Ahn H, Nikolova RG. A Web-based Simulator for Sample Size and Power Estimation in Animal Carcinogenicity Studies. *J Stat Software; Vol 1, Issue 13* . 2002. doi:10.18637/jss.v007.i13.
2. Ioannidis JPA. Why most published research findings are false. Jantsch W, Schaffler F, eds. *PLoS Med.* 2005;2(8):e124. doi:10.1371/journal.pmed.0020124.
3. Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schüz J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *BMJ.* 2011;343.

Appendix 1: Attempted replication of positive findings

```
# Review of NTP paper on cell phone RFR and certain cancers
# Attempt to reproduce the positive findings
# Data from Larry Tabak
# Code by Mike Lauer

setwd("~/Desktop/Files to save")

library(MCPAN)
library(rms)
library(Hmisc)

# Read in CDMA NTP data

CDMA <- read.csv("~/Desktop/Files to save/NTP CDMA Raw Tumor Data.csv")

# Survival and treatment group, adjusting for sex, by Cox proportional hazards

CDMA$status<-1
CDMA$S<-Surv(CDMA$Removal.Day, CDMA$status)
f<-cph(S~Treatment+Sex, data=CDMA)
f

# Survival greater (better) for 3.0W, P=0.0157, for 6.0W, P=0.0260

# Table 1 -- Poly-3 test for malignant glioma in males CDMA

males_CDMA<-subset(CDMA, Sex=='M')

poly3test(time=males_CDMA$Removal.Day, status=males_CDMA$Brain.Glioma.Malignant,
        f=males_CDMA$Dose, k=3, type='Williams', method='BW', alternative='greater')

# P=0.039

poly3ci(time=males_CDMA$Removal.Day, status=males_CDMA$Brain.Glioma.Malignant,
        f=males_CDMA$Dose, k=3, type='Williams', method='BW', alternative='greater')
```

Call result:

```
Sample estimates, using poly- 3 -adjustment
                 0       1.5     3      6
x                0.0000 0.0000 0.0000 3.0000
n                90.0000 90.0000 90.0000 90.0000
adjusted n       63.8258 72.3688 76.6821 64.8154
adjusted estimate 0.0000 0.0000 0.0000 0.0463

# Table 3 -- Poly-6 test for malignant Schwannoma in males CDMA

poly3test(time=males_CDMA$Removal.Day,
        status=males_CDMA$Heart.Schwannoma.Malignant, f=males_CDMA$Dose, k=6,
        type='Williams', method='BW', alternative='greater')

# P=0.0005

poly3ci(time=males_CDMA$Removal.Day,
        status=males_CDMA$Heart.Schwannoma.Malignant,f=males_CDMA$Dose,
        k=3,type='Williams', method='BW')

Call result:

Sample estimates, using poly- 3 -adjustment
               0    1.5     3     6
x            0.0000 2.0000 3.0000 6.0000
n            90.0000 90.0000 90.0000 90.0000
adjusted n       63.8258 72.3971 77.0575 66.5582
adjusted estimate 0.0000 0.0276 0.0389 0.0901

# Read in GSM NTP data

GSM <- read.csv("~/Desktop/Files to save/NTP GSM Raw Tumor data.csv")

# Survival and treatment group, adjusting for sex, by Cox proportional hazards

GSM$status<-1
GSM$S<-Surv(GSM$Removal.Day, GSM$status)
f<-cph(S~Treatment+Sex, data=GSM)
f

# Survival greater (better) for 6.0W, P=0.0048

males_GSM<-subset(GSM, Sex=='M')

# Table 3 -- Poly-6 test for malignant Schwannomas in males GSM
```

```
poly3test(time=males_GSM$Removal.Day, status=males_GSM$Heart.Schwannoma.Malignant,
    f=males_CDMA$Dose, k=6, type='Williams', method='BW', alternative='greater')

# P=0.004

poly3ci(time=males_GSM$Removal.Day, status=males_GSM$Heart.Schwannoma.Malignant,
    f=males_CDMA$Dose, k=3, type='Williams', method='BW', alternative='greater')
```

Call result:

```
Sample estimates, using poly- 3 -adjustment
                   0       1.5      3        6
x                  0.0000  2.0000   1.0000   5.0000
n                  90.0000 90.0000  90.0000  90.0000
adjusted n         63.8258 73.1547  76.1127  77.0723
adjusted estimate  0.0000  0.0273   0.0131   0.0649
```

Appendix 2: Simulations for power calculations

Power Simulations for NTP Cell Phone RFR paper (from
https://biostatistics.mdanderson.org/acss/Login.aspx and
https://www.jstatsoft.org/article/view/v007i13)[1]
Michael Lauer, MD (OER)
March 19, 2016

1) For malignant gliomas (Table 1), P = 0.005, HR = 2.5, k=3

The University of Texas M. D. Anderson Cancer Center
Sample Size and Power Estimation for Animal Carcinogenicity Studies

Reference: "A Web-based Simulator for Sample Size and Power Estimation in Animal Carcinogenicity Studies."
Hojin Moon, J. Jack Lee, Hongshik Ahn and Rumiana G. Nikolova,
Journal of Statistical Software. (2002)[1]

*** Input Parameters ***

Selected Seed = 3000
Number of Groups = 4
Dose metric of each group:
0.00 1.00 2.00 4.00
Number of animals in each group
90 90 90 90
Number of sacrifices including a terminal sacrifice = 1
Sacrifice time points in weeks:

Study duration = 90 weeks
Number of INTERIM sacrificed animals in each interval:
Background tumor onset probability at the end of the study = 0.01
Tumor onset distribution assumed: Weibull with a shape parameter 3.00
Hazard ratio(s) of dose vs. control group
1.50 2.00 2.50
Competing Risks Survival Rate (CRSR) for each group:
0.70 0.70 0.70 0.70
Tumor lethality parameter entered = 23.00
Level of the test = 0.01
One-sided or two-sided test = 2 sided test
Number of simulation runs = 5000

*** Simulation Results ***

dose group 0:
average tumor rate = 0.0149
average competing risks survival rate = 0.6990
average lethality = 0.0816

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0060	0.0000	0.0000
67	0.0002	0.0002	0.0334	0.0000	0.0000
78	0.0003	0.0005	0.0729	0.0000	0.0000
90	0.0005	0.0023	0.1855	0.0094	0.6887

dose group 1:
average tumor rate = 0.0225
average competing risks survival rate = 0.7000
average lethality = 0.0784

sacrifice time	d	a1	b1	a2	b2
45	0.0001	0.0000	0.0059	0.0000	0.0000
67	0.0003	0.0002	0.0325	0.0000	0.0000
78	0.0004	0.0008	0.0720	0.0000	0.0000
90	0.0007	0.0034	0.1851	0.0145	0.6842

dose group 2:
average tumor rate = 0.0297
average competing risks survival rate = 0.6997
average lethality = 0.0772

sacrifice time	d	a1	b1	a2	b2
45	0.0001	0.0000	0.0059	0.0000	0.0000
67	0.0004	0.0003	0.0331	0.0000	0.0000
78	0.0005	0.0012	0.0721	0.0000	0.0000
90	0.0010	0.0045	0.1829	0.0191	0.6790

dose group 3:
average tumor rate = 0.0366
average competing risks survival rate = 0.7007
average lethality = 0.0772

sacrifice time	d	a1	b1	a2	b2
45	0.0001	0.0000	0.0059	0.0000	0.0000
67	0.0005	0.0003	0.0330	0.0000	0.0000

78	0.0006	0.0013	0.0716	0.0000	0.0000
90	0.0012	0.0054	0.1812	0.0238	0.6749

Positive Trend (Power): 0.0238

2) For malignant Schwannomas (Table 3), P = 0.005, HR = 2.5, k=6

The University of Texas M. D. Anderson Cancer Center
Sample Size and Power Estimation for Animal Carcinogenicity Studies

Reference: "A Web-based Simulator for Sample Size and Power
Estimation in Animal Carcinogenicity Studies."
Hojin Moon, J. Jack Lee, Hongshik Ahn and Rumiana G. Nikolova,
Journal of Statistical Software. (2002)[1]

*** Input Parameters ***

Selected Seed = 3000
Number of Groups = 4
Dose metric of each group:
0.00 1.00 2.00 4.00
Number of animals in each group
90 90 90 90
Number of sacrifices including a terminal sacrifice = 1
Sacrifice time points in weeks:

Study duration = 90 weeks
Number of INTERIM sacrificed animals in each interval:
Background tumor onset probability at the end of the study = 0.01
Tumor onset distribution assumed: Weibull with a shape parameter 6.00
Hazard ratio(s) of dose vs. control group
1.50 2.00 2.50
Competing Risks Survival Rate (CRSR) for each group:
0.70 0.70 0.70 0.70
Tumor lethality parameter entered = 45.00
Level of the test = 0.01
One-sided or two-sided test = 2 sided test
Number of simulation runs = 5000

*** Simulation Results ***

dose group 0:
average tumor rate = 0.0149
average competing risks survival rate = 0.6990
average lethality = 0.0631

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0060	0.0000	0.0000
67	0.0001	0.0001	0.0335	0.0000	0.0000
78	0.0002	0.0003	0.0732	0.0000	0.0000
90	0.0005	0.0019	0.1859	0.0096	0.6887

dose group 1:
average tumor rate = 0.0225
average competing risks survival rate = 0.7000
average lethality = 0.0602

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0059	0.0000	0.0000
67	0.0001	0.0001	0.0326	0.0000	0.0000
78	0.0003	0.0005	0.0723	0.0000	0.0000
90	0.0006	0.0029	0.1856	0.0148	0.6842

dose group 2:
average tumor rate = 0.0297
average competing risks survival rate = 0.6997
average lethality = 0.0582

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0059	0.0000	0.0000
67	0.0002	0.0001	0.0333	0.0000	0.0000
78	0.0004	0.0007	0.0726	0.0000	0.0000
90	0.0009	0.0038	0.1837	0.0195	0.6790

dose group 3:
average tumor rate = 0.0366
average competing risks survival rate = 0.7007
average lethality = 0.0588

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0059	0.0000	0.0000
67	0.0003	0.0001	0.0332	0.0000	0.0000
78	0.0005	0.0007	0.0722	0.0000	0.0000
90	0.0011	0.0046	0.1821	0.0243	0.6749

Positive Trend (Power): 0.0230

3) For further consideration, P = 0.005, HR = 5, k=3

The University of Texas M. D. Anderson Cancer Center
Sample Size and Power Estimation for Animal Carcinogenicity Studies

Reference: "A Web-based Simulator for Sample Size and Power Estimation in Animal Carcinogenicity Studies."
Hojin Moon, J. Jack Lee, Hongshik Ahn and Rumiana G. Nikolova,
Journal of Statistical Software. (2002) In Press.

*** Input Parameters ***

Selected Seed = 3000
Number of Groups = 4
Dose metric of each group:
0.00 1.00 2.00 4.00
Number of animals in each group
90 90 90 90
Number of sacrifices including a terminal sacrifice = 1
Sacrifice time points in weeks:

Study duration = 90 weeks
Number of INTERIM sacrificed animals in each interval:
Background tumor onset probability at the end of the study = 0.01
Tumor onset distribution assumed: Weibull with a shape parameter 3.00
Hazard ratio(s) of dose vs. control group
2.00 3.50 5.00
Competing Risks Survival Rate (CRSR) for each group:
0.70 0.70 0.70 0.70
Tumor lethality parameter entered = 23.00
Level of the test = 0.01
One-sided or two-sided test = 2 sided test
Number of simulation runs = 5000

*** Simulation Results ***

dose group 0:
average tumor rate = 0.0149
average competing risks survival rate = 0.6990

average lethality = 0.0816

sacrifice time	d	a1	b1	a2	b2
45	0.0000	0.0000	0.0060	0.0000	0.0000
67	0.0002	0.0002	0.0334	0.0000	0.0000
78	0.0003	0.0005	0.0729	0.0000	0.0000
90	0.0005	0.0023	0.1855	0.0094	0.6887

dose group 1:
average tumor rate = 0.0301
average competing risks survival rate = 0.7000
average lethality = 0.0743

sacrifice time	d	a1	b1	a2	b2
45	0.0001	0.0000	0.0059	0.0000	0.0000
67	0.0004	0.0003	0.0324	0.0000	0.0000
78	0.0005	0.0011	0.0717	0.0000	0.0000
90	0.0009	0.0045	0.1839	0.0194	0.6789

dose group 2:
average tumor rate = 0.0515
average competing risks survival rate = 0.6997
average lethality = 0.0774

sacrifice time	d	a1	b1	a2	b2
45	0.0002	0.0000	0.0058	0.0000	0.0000
67	0.0007	0.0006	0.0328	0.0000	0.0000
78	0.0009	0.0020	0.0713	0.0000	0.0000
90	0.0017	0.0076	0.1795	0.0331	0.6638

dose group 3:
average tumor rate = 0.0727
average competing risks survival rate = 0.7007
average lethality = 0.0804

sacrifice time	d	a1	b1	a2	b2
45	0.0003	0.0000	0.0059	0.0000	0.0000
67	0.0010	0.0006	0.0327	0.0000	0.0000
78	0.0013	0.0028	0.0701	0.0000	0.0000
90	0.0025	0.0107	0.1755	0.0470	0.6496

Positive Trend (Power): 0.1420

4) For further consideration, same as in baseline (1) but with intermediate lethality

*** Input Parameters ***

Selected Seed = 3000
Number of Groups = 4
Dose metric of each group:
0.00 1.00 2.00 4.00
Number of animals in each group
90 90 90 90
Number of sacrifices including a terminal sacrifice = 1
Sacrifice time points in weeks:

Study duration = 90 weeks
Number of INTERIM sacrificed animals in each interval:
Background tumor onset probability at the end of the study = 0.01
Tumor onset distribution assumed: Weibull with a shape parameter 3.00
Hazard ratio(s) of dose vs. control group
1.50 2.00 2.50
Competing Risks Survival Rate (CRSR) for each group:
0.70 0.70 0.70 0.70
Tumor lethality parameter entered = 225.00
Level of the test = 0.01
One-sided or two-sided test = 2 sided test
Number of simulation runs = 5000

*** Simulation Results ***

dose group 0:
average tumor rate = 0.0149
average competing risks survival rate = 0.6990
average lethality = 0.3936

sacrifice time	d	a1	b1	a2	b2
45	0.0004	0.0000	0.0060	0.0000	0.0000
67	0.0014	0.0001	0.0334	0.0000	0.0000
78	0.0014	0.0004	0.0729	0.0000	0.0000
90	0.0019	0.0015	0.1855	0.0063	0.6887

dose group 1:
average tumor rate = 0.0225
average competing risks survival rate = 0.7000
average lethality = 0.3852

sacrifice time	d	a1	b1	a2	b2
45	0.0006	0.0000	0.0059	0.0000	0.0000
67	0.0022	0.0001	0.0325	0.0000	0.0000
78	0.0020	0.0006	0.0720	0.0000	0.0000
90	0.0029	0.0023	0.1851	0.0097	0.6842

dose group 2:
average tumor rate = 0.0297
average competing risks survival rate = 0.6997
average lethality = 0.3839

sacrifice time	d	a1	b1	a2	b2
45	0.0008	0.0000	0.0059	0.0000	0.0000
67	0.0029	0.0003	0.0331	0.0000	0.0000
78	0.0027	0.0008	0.0721	0.0000	0.0000
90	0.0039	0.0031	0.1829	0.0127	0.6790

dose group 3:
average tumor rate = 0.0366
average competing risks survival rate = 0.7007
average lethality = 0.3897

sacrifice time	d	a1	b1	a2	b2
45	0.0009	0.0000	0.0059	0.0000	0.0000
67	0.0037	0.0003	0.0330	0.0000	0.0000
78	0.0033	0.0009	0.0716	0.0000	0.0000
90	0.0048	0.0037	0.1812	0.0157	0.6749

Positive Trend (Power): 0.0219

References:

1. Moon H, Lee JJ, Ahn H, Nikolova RG. A Web-based Simulator for Sample Size and Power Estimation in Animal Carcinogenicity Studies. *J Stat Software; Vol 1, Issue 13* . 2002. doi:10.18637/jss.v007.i13.
2. Ioannidis JPA. Why most published research findings are false. Jantsch W, Schaffler F, eds. *PLoS Med*. 2005;2(8):e124. doi:10.1371/journal.pmed.0020124.
3. Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schüz J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *BMJ*. 2011;343.

Appendix G1: Reviewer's comments

Reviewer: Maxwell P. Lee, Ph.D., Laboratory of Cancer Biology and Genetics, NCI

I think the study was well designed and the analyses and results were clearly presented.

My main concern is the control data. Since the main finding was the increased incidence rates of heart schwannomas and brain gliomas in male Harlan Spragu Dawley rats exposed to GSM- or CDMA-modulated cell phone RFR, my analyses and evaluation below were focused on the male rats.

My concern regarding the control data came from the following two considerations. First, we need to consider sample variation. The incidence rates of the current controls for brain gliomas and heart schwannomas were 0. However, the historical controls were 1.67% for gliomas (range 0-8%) and 1.30% for schwannomas (0-6%). Given that there were substantial variations among the historical controls and the concurrent control is at the lowest end of the range, it is important to evaluate how different estimates of control incidence rates may impact the results of analyses. Supplementary Table S1 shows that for gliomas with 1.7% incidence rate we have 40%, 37%, 17%, and 6% of chance to observe 0 tumor, 1 tumor, 2 tumors, and greater than 2 tumors, respectively; heart schwannomas has similar distribution. Given the low incidence rate and moderate sample size of the control, even after observing 0 tumor in the current study, the 'true' incidence rate may be higher than 0. If we were repeating the experiment, we may see some control studies have 1 or more tumors. Second, it is puzzling why the control had short survival rate. Given that most of the gliomas and heart schwannomas are late-developing tumors, it is possible that if the controls were living longer some tumors might develop. Although the use of poly-3 (or poly-6) test intended to adjust the number of rats used in the study, it is still important to re-evaluate the analysis by considering the incidence rate in controls not being 0.

Therefore I have performed the analyses using the original data as well as the data modified by adding 1 tumor to the control. I implemented the poly-3 (or poly-6) trend test in R using the formula described in the file, Poly3 correction factor[1].docx.

The results are summarized in Table 1 for brain gliomas

Table 1. Incidence of brain gliomas in male rats exposed to GSM- or CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

RFR	W/kg				pvalue
	0	1.5	3	6	
GSM	0	3	3	2	0.9771
GSM	1	3	3	2	0.8668
CDMA	0	0	0	3	0.0233
CDMA	1	0	0	3	0.1077

18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Poly-6 adjusted rates were used in the chi-square trend test. The 1st and 3rd rows correspond to the original data with 0 tumor observed in the control group (Th numbers in Table 1 here are identical to those in Table 1 in the original report). The test is significant for CDMA exposures (pvalue = 0.0233). However, it is not significant after adding 1 tumor to the control group (pvalue = 0.1077, the 4th row).

Similar analysis was performed for heart schwannomas. The results are summarized in Table 2.

Table 2. Incidence of heart schwannomas in male rats exposed to GSM- or CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

RFR	W/kg				pvalue
	0	1.5	3	6	
GSM	0	2	1	5	0.0431
GSM	1	2	1	5	0.1079
CDMA	0	2	3	6	0.0144
CDMA	1	2	3	6	0.0365

Poly-3 adjusted rates were used in the chi-square trend test. The 1st and 3rd rows correspond to the original data with 0 tumor observed in the control group (Th numbers in Table 2 here are identical to those in Table 3 in the original report). The tests are significant for both GSM (pvalue = 0.0431) and CDMA (pvalue = 0.0144) exposures. However, only CDMA exposure remains significant after adding 1 tumor to the control group (pvalue = 0.0365, the 4th row).

Since the incidence of heart schwannomas in the 6 W/kg males was significantly higher in CDMA exposed males than the control group in the original report, I also analyzed the impact of adding 1 tumor to the control group

Table 3. Incidence of heart schwannomas in male rats exposed to 6 W/kg CDMA-modulated RFR, comparing control data with 0 vs. 1 tumor.

RFR	W/kg		pvalue
	0	6	
CDMA	0	6	0.0381
CDMA	1	6	0.0986

Poly-3 adjusted rates were used in the chi-square trend test. The 1st row corresponds to the original data with 0 tumor observed in the control group. The test was significant for CDMA exposures (pvalue = 0.0381). However, it was not significant after adding 1 tumor to the control group (pvalue = 0.0986, the 2nd row).

Conclusions

Increased incidence of heart schwannomas in male rats exposed to GSM- or CDMA-modulated RFR is statistically significant by the chi-square trend test. The evidence is better for CDMA exposure than GSM exposure. I think additional experiments are needed to assess if the incidence of brain gliomas in male rats exposed to GSM- or CDMA-modulated RFR is significantly higher than the control group or not.

My additional comments are summarized below.

1. I compared poly-3 adjusted number from Table 3 in the original repor versus the poly-3 adjusted number that I calculated using the raw data from the excel files. Supplementary Figure S1 shows that these two sets of numbers agre with each other in general. This is in contrast to the comparison for poly-6 adjusted number from Table 1 in the original report versus the poly-6 adjusted number that I calculated using the raw data from the excel files (Supplementary Figure S2). In fact, the adjusted rat numbers from Table 1 and Table 3 of the original report look quite similar (Supplementary Figure S3). This suggests that the poly-3 adjusted number was used in the footnotes in both Table 1 and Table 3 in the original report.

2. I noted that in Table S2 the adjusted numbers in from.original.report and poly3 are identical at Dose 0 and 1.5 for both CDMA and GSM as well as at Dose 3 for GSM but differ slightly in the other treatment doses for heart schwannomas. One possible cause of the difference is that the version of the raw data in the excel files differs from that used to generate the original report. The second possibility is typ in the footnote in Table 3. I also generated Table S3 that has the poly-6 adjusted numbers for brain gliomas. The two sets of the poly-6 adjusted numbers are ver different.

3. There are a couple of errors in the footnote of Table in the original report. 2/74.05 (5%) should be 2/74.05 (2.7%). 3/78.67 (4%) should be 3/78.67 (3.8%).

Supplementary Information

Table S1. Expected percentage of observing different numbers of tumors in the controls based on binomial distribution.

	0 tumor	1 tumor	2 tumors	>2 tumors
control for glioma	40%	37%	17%	6%
control for heart schwannoma	43%	37%	15%	5%

The percentage was calculated with 1.7% historical control rate for male rats (gliomas) and with poly-6 adjusted animal number, 53. Similarly, the percentage was calculated with 1.3% historical control rate for male (heart schwannoma) and with poly-3 adjusted animal number, 65.

Table S2. The poly-3 adjusted rat numbers in Table in the original report and those calculated from the raw data.

RFR	Dose	from.original.report	poly3
CDMA	0	65.47	65.47
CDMA	1.5	74.05	74.05
CDMA	3	78.67	78.35
CDMA	6	67.94	66.24
GSM	0	65.47	65.47
GSM	1.5	74.87	74.87
GSM	3	77.89	77.89
GSM	6	78.48	77.66

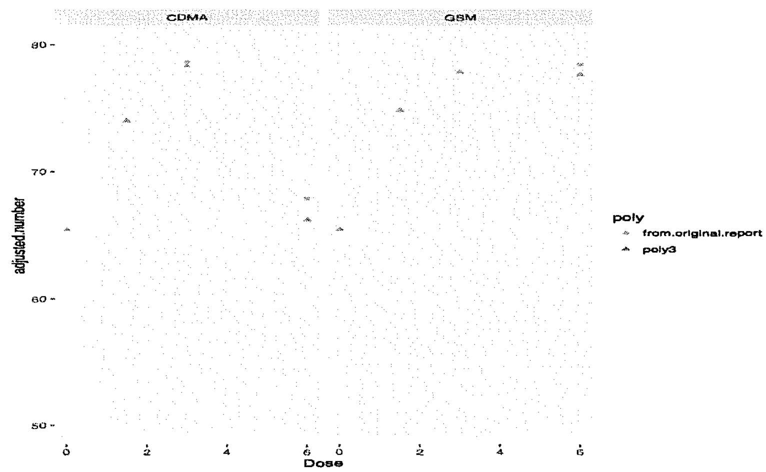
The numbers in from.original.report refers to the poly-3 adjusted rat number from Table 3 in the original report. The numbers in poly3 refers to the poly-3 adjusted rat numbers that I calculated from the raw data for heart schwannoma.

Table S3. The poly-6 adjusted rat numbers in Table in the original report and those calculated from the raw data.

RFR	Dose	from.original.report	poly6
CDMA	0	65.47	53.48
CDMA	1.5	74.05	65.94
CDMA	3	78.35	73.08
CDMA	6	66.24	57.5
GSM	0	65.47	53.48
GSM	1.5	74.93	67.84
GSM	3	78.27	71.43
GSM	6	77.1	72.55

The numbers in from.original.report refers to the poly-6 adjusted rat number from Table 1 in the original report. The numbers in poly6 refers to the poly-6 adjusted rat numbers that I calculated from the raw data for brain gliomas.

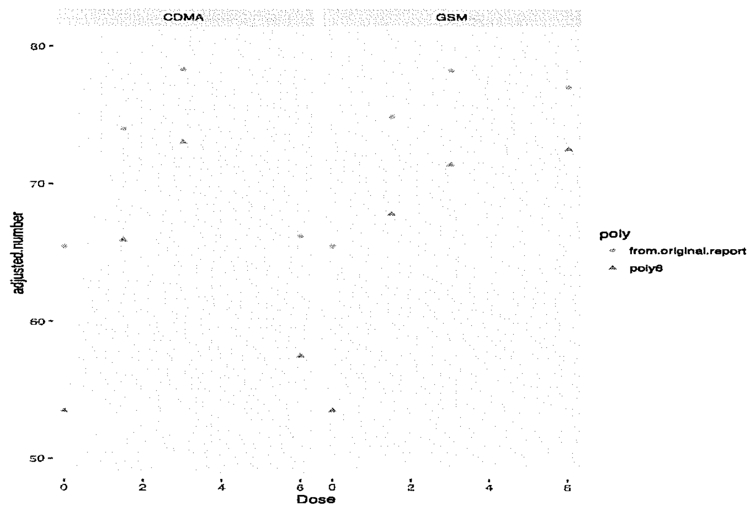
Figure S1. Comparison of poly-3 adjusted rat numbers between those from the original report versus those calculated from the raw data.



The poly-3 adjusted rat number from Table 3 of the original report is compare with the poly-3 adjusted rat number that I calculated from the raw data for heart schwannomas experiment

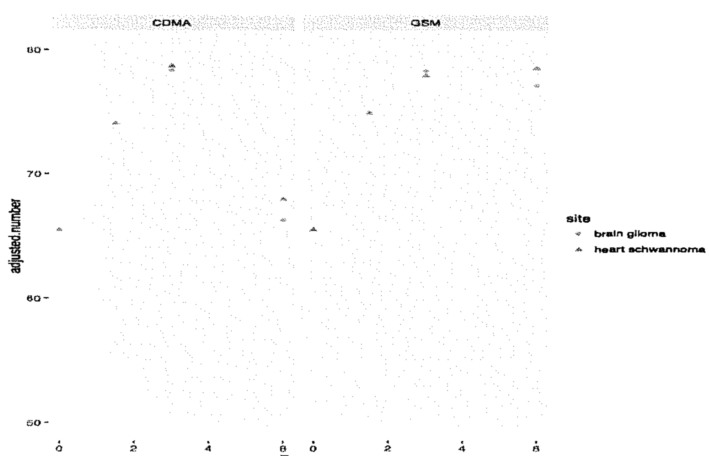
18-0161 Public Comment
PC Rcvd 01-18-18 to 01-25-18

Figure S2. Comparison of poly-6 adjusted rat numbers between those from the original report versus those calculated from the raw data.



The poly-6 adjusted rat number from Table 1 of the original report is compare with the poly-6 adjusted rat number that I calculated from the raw data for brain gliomas experiment

Figure S3. Comparison of poly-6 adjusted rat numbers between those from the original report versus those calculated from the raw data.



The adjusted rat numbers from Table 1 and Table 3 of the original report are compared with each other.

Appendix G1: Reviewer's comments

Reviewer: Aleksandra M. Michalowski, M.Sc., Ph.D., Laboratory of Cancer Biology and Genetics, NCI

REVIEWER COMMENTS

Reviewer's Name:
Aleksandra M. Michalowski, Ph.D., M.Sc., National Cancer Institute/LCBG

Report Title:
Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation (Whole Body Exposures); Draft 3-16-2016

Charge: To peer review the draft report and comment on whether the scientific evidence supports NTP's conclusion(s) for the study findings.

1. Scientific criticisms:

   a. *Please comment on whether the information presented in the draft report, including presentation of data in any tables, is clearly and objectively presented. Please suggest any improvements.*

Overall, the information included in the report is presented in a comprehensive and accurate manner. Specifically, the experimental design and conditions are sufficiently documented and the choice of statistical approaches is explained; the results are well organized and necessary details are provided.

Nevertheless, a few additions could be suggested:

(1) Appendix tables for all poly-k tests performed could be added. I believe this would enhance the presentation of the adjusted rates and the strength of the statistical evidence. As a possible example I prepared the below table using the R package *MCPAN* and its *poly3test()* function.

poly-3	Heart Schwannoma Malignant, Male				Heart Schwannoma Malignant, Female			
CDMA exposure	0	1.5	3	6	0	1.5	3	6
X	0	2	3	6	0	2	0	2
N	90	90	90	90	90	90	90	90
adjusted n	63.8	72.4	77.1	66.6	67.9	71.8	70.3	78.0
Dunnett contrast	–	1.5 - 0	3 - 0	6 - 0	–	1.5 - 0	3 - 0	6 - 0
Estimate	0	0.03	0.04	0.09	0	0.03	0	0.03
Statistic	–	1.24	1.58	2.45	–	1.26	0	1.24
p-value	–	0.2704	0.1542	**0.0209**	–	0.2466	0.7992	0.2562
Williams contrast	–	(6,3,1.5) - 0	(6,3) - 0	6 - 0	–	(6,3,1.5) - 0	(6,3) - 0	6 - 0
Estimate	0	0.05	0.06	0.09	0	0.02	0.01	0.03
Statistic	–	2.78	2.75	2.45	–	1.27	0.88	1.24
p-value	–	**0.0056**	**0.0060**	**0.0138**	–	0.1661	0.2871	0.1744

(2) In the portion of the text describing poly-k test results, p-values are given for significant pairwise comparisons; I would also give the p-values estimated for the significant trends (maximum test).

(3) Information could be included regarding the software or programming environment used for the computations.

(4) In the portion of the text describing differences in survival at the end of the study between control and RFR-exposed animals (page 5§2) the compared characteristic is not named (median survival, TSAC?) and also no numerical values of the estimates or the range of differences are given. I would add numbers in the text or an Appendix table showing the group survival estimates described in this paragraph.

Median survival

CDMA	Female	Male	GSM	Female	Male
0	737	662.5	0	737	662.5
1.5	734	719	1.50	738	729
3	737	731	3	737	730
6	738.5	717	6	738	731

TSAC percentage

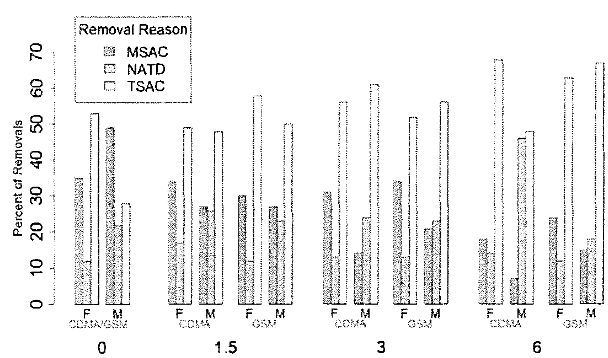
CDMA	Female	Male	GSM	Female	Male
0	53	28	0	53	28
1.5	49	48	1.5	58	50
3	56	61	3	52	56
6	68	48	6	63	67

b. *Please comment on whether NTP's scientific interpretations of the data are objective and reasonable. Please explain why or why not.*

Appropriate statistical design and methods were applied in accord with the FDA/NTP guidelines for conducting long-term rodent carcinogenicity studies and analyses. The results and limiting issues were objectively discussed. The critical issue of shorter survival in the male control group was addressed with regard to the percentage of animals surviving to terminal sacrifice in historical control data (avg. 47%, range 24% to 72%) and the possible impact of the observed age of tumor occurrence on the statistical inference.

I believe detailed information about animal selection and randomization procedures should be given so that the potential for allocation bias could be judged. As shown in the figure below, the lower survival rate to terminal sacrifice (28%) in the male control is accompanied by the higher rate of moribund sacrifice (49%); in the male group exposed to CDMA with 6 W/kg, a higher rate of natural death was observed (46%).

It has been reported that insufficient randomization can lead to differences in survival rates. As an example, in a carcinogenicity study on aspartame it was suggested that lack of randomization to different rooms may have possibly been the cause of low survival rates (27%) in the control female group due to a high background infection rate (EFSA, 2006; Magnuson, B., Williams, G.M., 2008).



2. Please identify any information that should be added or deleted:

A statement of the required statistical significance level should be added. FDA guidance suggests the use of significance levels of 0.025 and 0.005 for tests for positive trends in incidence rates of rare tumors and common tumors, respectively; for testing pairwise differences in tumor incidence the use of significance levels of 0.05 and 0.01 is recommended for rare and common tumors, respectively. If power calculations to determine the required sample size were performed, the results should also be included.

3. The scientific evidence supports NTP's conclusion(s) for the study findings:

The NTP's overall draft conclusion was as follows: "Under the conditions of these studies, the observed hyperplastic lesions and neoplasms outlined in this partial report are considered likely the result of exposures to test article A and test article B. The findings in the heart were statistically stronger than the findings in the brain."

In my view, the results support the conclusion of likely carcinogenic effect of the RFR-exposure on Schwannoma heart lesions in male Harlan Sprague Dawley rats.

Possible carcinogenic effects in the brain are marginal and are not sufficiently supported by statistical evidence in the male Harlan Sprague Dawley rats.

In the female Harlan Sprague Dawley rats very few lesions were observed in either site and statistical significance was not reached at all.

Appendix G1: Reviewer's comments

Reviewer: R. Mark Simpson, D.V.M., Ph.D., Laboratory of Cancer Biology and Genetics, NCI

Analysis of National Toxicology Program (NTP) study evaluating risk in rat lifetime exposure to GSM or CDMA RFR.

Notes:

The NTP study document acknowledges several study limitations [page 10, discussion section]. Potential limitations should prominently factor into considerations regarding the context of the findings, as well as their interpretation and application.

Working list of limitations potentially impacting NTP study interpretations

- Difficulty in achieving diagnostic consensus in lesions classifications of rare, unusual, and incompletely understood lesion association
- Document appears to indicate that the second Pathology Working Group (PWG) empaneled to review and obtain lesion classification consensus, following the inability of the initial PWG to do so, may have reviewed different lesions sets
- No record of clinical disease manifestations due to lesions involving heart and brain [note lesions in heart and brain are mutually exclusive; affected rats have either one or the other and do not appear to have the involvement of both organs together (appendix E)]
- Lesions, including malignancies, do not appear to materially shorten lifespan, except for a subgroup of rats (less than 1/3 of affected rats) with malignant Schwannomas in heart
- Lack of shortened lifespan as a consequence of malignancy for the majority of affected rats contrasts with shortened lifespan of male control rats for which there is absence of attributable cause of death. The survival of the control group of male rats in the current study (28%) was relatively low compared to other recent NTP studies (avg 47%, range 24 to 72%).
    Creates greater reliance on statistical controlling for survival disparities and reliance on historical controls
- Reliance on historical controls made up of rats of different genetic strain background, held under different environmental conditions
- Absence of data on incidence of more frequently expected tumor occurrences in rats (background lesions)

Documenting the nature of the brain and cardiac lesions observed in RFR exposed rats and placing them into test article exposure-related context, in contrast to potential for their occurring spontaneously, are important and challenging goals. The NTP study limitations make the interpretation of reasonable risk more complicated. NTP acknowledgements of study limitations appear factored into one of NTP's reviewer's study conclusion, i.e., findings represent "some evidence" for a test article effect in statistically significant trend for Schwannomas; an opinion which is coupled with a conclusion for "equivocal evidence" of an effect in relation to malignant gliomas of the brain [NTP Appendix F, Reviewer Comments].

The summation from Appendix F reviewers regarding existence of test article effect is less than conclusive. The NTP study documents a series of cytoproliferative changes in heart and brain. The nature of some of the changes is challenging diagnostically and appears to be incompletely understood. These findings are presented in the absence of complete analysis of the entire consequences of the study effects. For example, no potential significance for test article effect context is given to any of granular cell proliferative lesions of the brain, a finding mentioned only as a contrast to what was less well understood pathologically (NTP Appendix C, Pathology). It is noteworthy that the lesion types analyzed in the NTP RFR study under review are uncommon historically in rats, in the organs discussed. Furthermore, the malignancies of neuroglia appear to be paired with the occurrence of poorly understood changes involving neuroglial cell hyperplasias in the central and peripheral nervous systems. Little information can be gleaned from the literature about the nature and significance of these latter proliferative changes, interpreted by NTP as nonneoplastic and non-inflammation-reactive neuroglial cell in nature. Although unclear in the NTP study document, it is plausible that the particular lesion constellation, along with the relative novelty of some lesions, contributed to the lack of consensus regarding the nature of the lesions on the part of the initial PWG study pathologists. Concern raised by one of the reviewers (Appendix F, Reviewer Comments) regarding how this difficulty in ability to classify lesions might impact comparisons to historical control lesion incidence data (NTP Table D) is certainly principled.

The extraordinary PWG process, presumably posed by the difficult diagnostic interpretations, has the potential to influence the reliance on historical controls. In this regard, study limitations concerning determination of whether or not there is a test article effect include the substantially poor survival of male rats in the control group. The survival of the control group of male rats in the study under review (28%) was relatively low compared to other recent NTP studies (avg 47%, range 24 to 72%). This apparently led to greater statistical construction to account for the impact of study matched controls, and created increased reliance upon historical data of rare tumor incidences in control animals taken from other chronic carcinogenicity studies. NTP acknowledges a limitation in using the historical incident data and a small study match control group due to poor survivability. There are potential sources of variability when using historical controls of different rat strains and fluctuating study conditions (environment, vehicle, route of exposure, etc.), as is the case here. It seems less than clear what appropriate background lesion incidence is, as NTP indicates some data involve other strains of rats. The range of lesion incidence in historical controls could mean that the true incidence of some lesions varies considerably and might be considered rare or more common depending upon the incidence rate.

The guidance manual on Statistical Aspects of the Design, Analysis and Interpretation of Chronic Rodent Carcinogenicity Studies of Pharmaceuticals by the FDA provided for this review discusses applying comparisons using historical control lesion incidences at some length [beginning page 27, line 996]. Considering lesions as being rare or more common appears to influence selection of the level of statistical significance for comparisons. It appears that analysis for significant differences in tumor incidence between the control and the dose groups for these NTP studies has been established at the 0.05 level (NTP Tables 1,3,5). Interpretations of trend tests may be influenced by the choice of decision rule applied. Such choices can result in about twice as large overall false positive error as that associated with control-high pairwise comparison tests [page 28, line 1012-1026]. The FDA guidance manual [page 31, line 1136] highlights concern regarding reliance upon historical control incidence data, stating that using historical control data in the interpretation of statistical test results is not very satisfactory because the range of historical control rates is usually too wide. This is especially true in situations in which the historical tumor rates of most studies used are clustered together, but a few other studies give rates far away from the cluster. When the range of historical control data is simply calculated as the difference between the maximum and the minimum of the historical control rates, the range does not consider the shape of the distribution of the rates. These circumstances may impose some limitations on optimal risk assessment designs.

Somewhat paradoxically then, NTP study limitations including that imposed due to reliance upon less than optimal historical control lesion incidence data for much of the comparisons between treated and untreated rats, is confronted by existence of a difficult to classify and incompletely understood lesion constellation interpreted to include neuroglial cell hyperplasia. Notwithstanding, this confounding proliferative lesion occurring in the context along with malignancies of apparently similar histogeneses, sustains a level of concern for a rare injury mechanism related to test article effect. Additional information about the study together with an assessment of the statistical analyses may enhance the value of this analysis.

R. Mark Simpson, D.V.M., Ph.D.