Cell Phones, Cell Towers, and Wireless Safety

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“Balancing Technology”
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Saferemr.com
Cell Phone Basics

The intensity of Radio waves at ground level shall be much lesser than that of in Main Beam direction.
Rapid growth in cell phone use

- 400 million “subscriber connections”
- $179 billion annual revenue
- 88 hours/year avg. voice use
- CTIA: Dec. 2017

Rapid growth in smartphone use

Reported Smartphones Grew 5.5x from 2009
Device use is prevalent among teens

<table>
<thead>
<tr>
<th>Device Ownership among U.S. Teens, by Demographic Group</th>
<th>U.S. Teens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone</td>
<td>95</td>
</tr>
<tr>
<td>Cellphone that is not a smartphone</td>
<td>29</td>
</tr>
<tr>
<td>Desktop or laptop computer</td>
<td>88</td>
</tr>
<tr>
<td>Gaming console</td>
<td>84</td>
</tr>
</tbody>
</table>

Source: Survey conducted March 7-April 10, 2018. “Teens, Social Media & Technology 2018”
PEW RESEARCH CENTER

http://bit.ly/Pewsurvey2018
Demise of the landline telephone

US Households (Jan-Jun, 2018)

- 54.9% wireless-only
- 36.3% mixed-use
- 5.4% landline-only
- 3.3% no phone

NHIS. NCHS, CDC. Dec., 2018.
How do cell phones work?

Cell phones are radio devices — they communicate by transmitting and receiving voice over an area.

First a cell phone radios the nearest cell tower (or site). When you make a call or turn your phone on, your phone sends a message via radio that's picked up by the tower's antennas.

Next, a wire or fiberoptic line carries the call down to the wireless access point, connected to a multi-port switch.

The call (along with many others) gets routed to a backhaul — usually down to an underground wired T1 or T3 line, but sometimes back up the mast to a powerful line-of-sight wireless microwave antenna (typically only used either when there isn't a ground connection, or when the ground connection is poor).

The incoming call or data comes back from the backhaul and up through the switch to the antenna, where it then hits your phone (presuming your phone is still communicating with the same site). If you are moving, then there's a handoff—a new but more or less identical cell site transmits the data to your phone, once your phone checks in.
Rapid growth in cell antenna sites

Cell Sites in Service

A Record 323,448 Cells Sites Were in Operation in 2017, Representing 52% Growth Over the Last Decade

Cell Tower Health Effects
Cell antennas vary greatly

**Different sizes of cell antennas**

"Macro cell" towers can be up to 400 feet tall and send their signals several miles. Sometimes cities require that they be covered in fake tree branches to blend in with the environment. Small cells are typically placed on streetlights or traffic signals in dense areas and cover a smaller radius.

Option A permits:
- Streetlight
- Utility Poles

Flush Mounted
- Pole Topper
- Flush Mounted
- Pole Topper

Pole Tip antennas may extend past height by no more than 6 feet.

Flush mounts are utilitarian to meet city requirements of non-prominence, size restrictions.
Research
IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

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

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<tr>
<td>“Heavy” Lifetime Use</td>
<td>1.40* 1640+ hrs</td>
<td>1.82* 1640+ hrs</td>
<td>1.75* 1640+ hrs</td>
<td>2.89* 896+ hrs</td>
</tr>
<tr>
<td>10+ years</td>
<td>0.98</td>
<td>2.18*</td>
<td>1.79*</td>
<td>1.61</td>
</tr>
</tbody>
</table>

Estimated lifetime risk of glioma in US is from 1 in 200 to 1 in 250.

78,000 malignant & non-malignant brain tumors per year in U.S.
Child’s brain absorbs 2X the radiation

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

Gandhi et al., 2012
Children’s brain tumor risk

- **CEFALO**
  - 998 7-19 year olds from Denmark, Sweden, Switzerland, Norway
  - Overall 36% ↑ risk for “regular” cellphone use (ns)
  - Subgroup w/ cell phone company records: 2.8+ years of cellphone use → 214% ↑ risk (signif.)

- **MOBI-Kids**
  - 1,810 10-24 year olds from 14 nations
  - Data collected: 2009-2014
  - Final results: 2019?
National Toxicology Program Study: Final Reports (2018)

Cell Phone Radio Frequency Radiation Studies

What did the studies find?
NTP studies found that exposure to high levels of RFR, like that used in 2G and 3G cell phones, was associated with:

- **Clear evidence of tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of tumors in the brains of male rats.** The tumors were malignant gliomas.
- **Some evidence of tumors in the adrenal glands of male rats.** The tumors were pheochromocytomas.

For female rats, and male and female mice, it was unclear, also known as equivocal, whether cancers observed in the studies were associated with exposure to RFR.

Do the rat and mouse findings apply to humans?
The findings in animals cannot be directly applied to humans for two key reasons:

- The exposure levels and durations were greater than what people may receive from cell phones.
- The rats and mice received RFR across their whole bodies, which is different from the more localized exposures humans may receive, like from a cell phone in their pocket or next to their head.

However, the studies question the long-held assumption that radio frequency radiation is of no concern as long as the energy level is low and does not significantly heat the tissues.
NTP Study: Other effects

- DNA damage in brains of male & female mice & rats.
- Increased degeneration in hearts of male & female rats.
- Decreased birth weights in rats exposed prenatally.
- Overall tumor incidence in male rats was greater after 2 years of cell phone radiation exposure (in Appendix).
  - Highest overall cancer incidence (42%-46%) in middle exposure groups (3 watts per kilogram [W/kg]); significantly greater than sham control group (27%).
  - Lowest exposure groups (1.5 W/kg) had significantly greater non-malignant tumor incidence (73%-76%) vs. sham control group (54%).
- Ramazzini Institute study
  Replicates the key NTP results.
Health risks in humans from cell phone use

- **Tumors**: glioma (glial cells), acoustic neuroma (Schwann cells), meningioma, parotid, pituitary & thyroid glands; breast
- **Reproductive harm**: sperm damage, male infertility, miscarriage, preterm birth
- **Prenatal/children**: headaches, hearing problems, impaired memory, ADHD, autism?
- **Electrohypersensitivity**: fatigue, headaches, insomnia, tinnitus, heart palpitations, etc.
Electrohypersensitivity vs. demyelination symptoms

<table>
<thead>
<tr>
<th>TABLE 1. Symptoms Reported by People After Exposure (or Presumed Exposure) to RF-EMFs With Symptoms of Demyelination</th>
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<tr>
<td><strong>Vision</strong></td>
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<td><strong>Cerebellar</strong></td>
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*Note. Sources: ESUK (2014); Mar (2014); National Multiple Sclerosis Society (2014).*
## Table 1: Summary of Epidemiological Studies of Mobile Phone Base Station Health Effects

<table>
<thead>
<tr>
<th>Publication (Year, Country)</th>
<th>Clinical Assessment</th>
<th>Study Design</th>
<th>Base Station Details</th>
<th>Participants</th>
<th>EMF Measured</th>
<th>Key Findings</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nova et al. (2003, Spain)</td>
<td>Neuro-behavioral</td>
<td>Survey-questionnaire</td>
<td>GSM DCS 1500 MHz</td>
<td>101</td>
<td>Yes</td>
<td>More symptoms with closer proximity to base station (&lt; 150 m)</td>
<td>Detailed questionnaire, EMF measured, distances studied&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Low participation, self-estimated distances, subjects aware&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Santini et al. (2003, France)</td>
<td>Neuro-behavioral</td>
<td>Survey-questionnaire</td>
<td>n/s</td>
<td>530</td>
<td>No</td>
<td>More symptoms with closer proximity to base station (&lt; 300 m)</td>
<td>Detailed questionnaire, distances &amp; other EMF exposures assessed</td>
<td>As above, plus no EMF measurements, no base station details</td>
</tr>
<tr>
<td>Eger et al. (2004, Germany)</td>
<td>Cancer incidence</td>
<td>Retrospective case review</td>
<td>GSM 955 MHz</td>
<td>957</td>
<td>No</td>
<td>3 x risk of cancer after 5 yrs of exposure (&lt; 400 m), early age of cancer diagnosis</td>
<td>Maximum beam intensity calculated, reliable cancer data collection</td>
<td>Other environmental risk factors not assessed: analysis not adjusted for age and sex.</td>
</tr>
<tr>
<td>Wolf &amp; Wolf (2004, Israel)</td>
<td>Cancer incidence</td>
<td>Retrospective case review</td>
<td>TDMA 950 MHz</td>
<td>1844</td>
<td>Yes</td>
<td>&gt; 4 x risk of cancer after 5-7 yrs exposure (&lt; 350 m), early age of cancer diagnosis</td>
<td>Reliable cancer &amp; demographic data, no other major environmental pollutant identified</td>
<td>Not all environmental risk factors assessed: possible selection bias, no age, sex adjustment.</td>
</tr>
<tr>
<td>Ogdala et al. (2006, Poland)</td>
<td>Neuro-behavioral</td>
<td>Survey-questionnaire</td>
<td>n/s</td>
<td>500</td>
<td>No</td>
<td>More headache with proximity, &lt; 150 m; nocebo unlikely</td>
<td>Detailed questionnaire, distances &amp; EMF studied, nocebo studied</td>
<td>Subjects aware, no base station details</td>
</tr>
<tr>
<td>Hutter et al. (2006, Austria)</td>
<td>Neuro-behavioral</td>
<td>Cross-sectional</td>
<td>900 MHz</td>
<td>336</td>
<td>Yes</td>
<td>Headaches &amp; impaired concentration at higher power density; nocebo unlikely</td>
<td>Detailed questionnaire and testing, EMF measured, distances studied; nocebo effect studied</td>
<td>Subjects aware, low participation rate</td>
</tr>
<tr>
<td>Meyer et al. (2006, Germany)</td>
<td>Cancer incidence</td>
<td>Retrospective case review</td>
<td>n/s</td>
<td>177,428</td>
<td>No</td>
<td>No increased cancer incidence in municipalities with or without base stations</td>
<td>Wide population assessed (Bavaria)</td>
<td>Observation period only 2 years; vague definitions of exposure, exposure onset unknown, distance to base station unknown</td>
</tr>
<tr>
<td>Abdel-Raouf et al. (2007, Egypt)</td>
<td>Neuro-behavioral</td>
<td>Cross-sectional</td>
<td>n/s</td>
<td>165</td>
<td>Yes</td>
<td>More symptoms &amp; lower cognitive performance living under or &lt; 10 m from base station</td>
<td>Detailed questionnaire and testing, EMF measured, distances studied, subjects unaware</td>
<td>Exact base station details n/s, low number of participants</td>
</tr>
<tr>
<td>Bischof et al. (2009, Germany)</td>
<td>Neuro-behavioral</td>
<td>Cross-sectional</td>
<td>n/s</td>
<td>30,047</td>
<td>No</td>
<td>More health complaints closer to base station (&lt; 300 m)</td>
<td>Wide population assessed, detailed survey, nocebo effect assessed</td>
<td>EMF measurements not carried out (see phase III Berg-Birckhoff et al., 2009, below)</td>
</tr>
<tr>
<td>Berg-Birckhoff et al. (2009, Germany)</td>
<td>Neuro-behavioral</td>
<td>Cross-sectional</td>
<td>GSM 900 MHz</td>
<td>1326</td>
<td>Yes</td>
<td>Health effects probably caused by stress and not by RF-EMF</td>
<td>Measured EMF emissions, standardized questionnaires</td>
<td>Low participation, no detailed list of symptoms published, single &quot;spot&quot; measurement in one place in dwelling, no occupational exposure assessed, the lag from assessment of symptoms and EMF measurement</td>
</tr>
</tbody>
</table>

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<sup>a</sup> Distance refers to distance between base stations and subjects' households.<br>
<sup>b</sup> Subjects aware refers to study participants being aware of the nature of the study.<br>
<sup>c</sup> Nocebo effect unlikely because the majority of subjects in the study reported little or no concern for base station proximity.
International EMF Scientist Appeal

• Calls for stronger regulation of EMF (electromagnetic fields) & health warnings.
• Signed by 247 EMF scientists (2019).
  – Published >2,000 EMF papers; 42 nations.

Scientific basis for our common concerns
“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 plant and animal life.”

EMFscientist.org
"5G … could also harm your health. Europe's governments ignore the danger."

Investigate Europe, a team of journalists, identified 14 scientists who defend ICNIRP's obsolete exposure guidelines by preparing biased reviews of the scientific literature. At least eight have had industry research funding.


1996 Telecommunications Act pre-empts consideration of health effects in placement of cell towers

Without completely preemptioning the authority of local governments to make decisions regarding the placement of wireless communications facilities, the Act provides five separate and substantial protections for the telecommunications facility applicant in the amended 47 U.S.C. § 332 (entitled National Wireless Telecommunications Siting Policy). Section 332 provides that:

(D) no state or local governmental entity may regulate the placement, construction, or modification of personal wireless service facilities on the basis of environmental effects of radio frequency emissions to the extent that such emissions comply with FCC regulations; and
U.S. government: “Wait and see”

- **Wait and see:** demands conclusive evidence
  - Federal govt. made minimal investment in research
    - 1999: FDA called for NTP cell phone radiation study
    - 2018: NTP final reports released
  - Cities of Boston & Philadelphia (2013): “overlap of federal agency responsibilities … leaves leadership unclear and encourages a pass-the-buck attitude.”
  - U.S. Dept of Interior (2014): ”electromagnetic radiation standards used by the FCC continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today.”
  - Senator Richard Blumenthal (2019) re: 5G

At the end of the exchange, Blumenthal concluded, “So there really is no research ongoing. We’re kind of flying blind here, as far as health and safety is concerned.”
Agencies & organizations call for changes in FCC’s RF limits or testing
US federal & WHO websites: Misleading risk minimization language

- **NCI**: “currently no consistent evidence that non-ionizing radiation increases cancer risk … The only consistently recognized biological effect of radiofrequency energy is heating.”
- **FDA**: “The scientific evidence does not show a danger to any users of cell phones from RF exposure, including children and teenagers.”
- **FCC**: “currently no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses.”
- **WHO**: “To date, no adverse health effects have been established as being caused by mobile phone use.”
“The FCC, the FDA, the WHO, the American Cancer Society and numerous other international and U.S. organizations and health experts say that the scientific evidence shows no known health risk due to the RF energy emitted by cellphones.”

CTIA, Feb 9, 2018

Microwave News & The Nation

A Report on Non-Ionizing Radiation

About Us

For more than 35 years, Microwave News has been reporting on the potential health and environmental impacts of electromagnetic fields and radiation. We are widely recognized as a fair and objective source of information on this controversial subject.

http://Microwavenews.com

How Big Wireless Made Us Think That Cell Phones Are Safe: A Special Investigation

The disinformation campaign—and massive radiation increase—behind the 5G rollout.

By Mark Hertsgaard and Mark Dowie

San Francisco: Cell phone “right to know” ordinance

- 2010: SF Board of Supervisors adopted law
- 2010: CTIA filed federal lawsuit
- 2011: Supervisors revised fact sheet based on judge’s ruling
- 2012: 9th Circuit Appeals Court overturned lower court in unpublished opinion
- 2013: Supervisors killed law

City of Berkeley: Cell phone “right to know” ordinance

- 2015: City Council adopted law
- 2015: CTIA filed federal lawsuit
- 2015: City adopted minor revision based on court ruling
- 2016: Law took effect
- 2017: 9th Circuit Appeals Court upheld federal District Court
- 2018: CTIA appealed to U.S. Supreme Court; case returned to 9th Circuit

The City of Berkeley requires that you be provided the following notice:

To assure safety, the Federal Government requires that cell phones meet radio frequency (RF) exposure guidelines. If you carry or use your phone in a pants or shirt pocket or tucked into a bra when the phone is ON and connected to a wireless network, you may exceed the federal guidelines for exposure to RF radiation. Refer to the instructions in your phone or user manual for information about how to use your phone safely.
2009: CDPH drafted cell phone safety guidance but suppressed it
2014: Three public records requests
2016: Lawsuit by UC Berkeley Environ. Law clinic & First Amendment Project
2017: Court ordered release of draft guidance documents
2017: CDPH published final guidance

Next Step: Now every city and county can disseminate this document.

How to Reduce Exposure to Radiofrequency Energy from Cell Phones

The use of cell phones has increased dramatically in recent years, including among children and young adults. These phones put out radio frequency (RF) energy.

Some scientists and public health officials believe RF energy may affect human health. This guidance document describes RF energy, lists some of the potential health concerns, and provides guidance on how people can reduce their exposure.

Why are people concerned about exposure to RF energy from cell phones?

Although the science is still evolving, some laboratory experiments and human health studies have suggested the possibility that long term, high use of cell phones may be linked to certain types of cancer and other health effects, including:

- brain cancer and tumors of the acoustic nerve
- headaches and effects on learning and memory
- hearing, behavior, and sleep
- lower sperm counts and inactive or less mobile sperm
- heart rate fluctuations
- lower cell phone use

These studies do not establish the link definitively, however, and scientists disagree about whether cell phones cause these health problems and how great the risks might be. This document is intended to provide guidance for those people who want to reduce their own and their families’ exposures to RF energy from cell phones, despite this uncertainty.

What is RF energy?

Cell phones work by sending and receiving signals to and from cell phone towers. These signals are a form of electromagnetic radiation called radiofrequency (RF) energy. Other sources of RF energy include cell phone towers, TV and radio transmitters, smart meters, and microwave ovens. When a phone sends signals to a tower, the RF energy goes from the phone’s antenna out to all directions, including into the head and body of the person using the phone. Cell phones also emit RF energy when using WiFi and/or Bluetooth, but at lower levels.

RF energy is not as powerful or as damaging to cells or DNA as some other kinds of electromagnetic radiation, such as X-rays or UV rays from the sun. Some scientific studies have, however, suggested there may be increased health risks from exposure to RF energy.

How can you reduce your exposure?

Keep your phone away from your body. Keeping your phone just a few inches away from you can make a big difference.

- When you talk on your cell phone, avoid holding it to your ear—use the speakerphone or a headset instead. Wireless (Bluetooth) and wired headsets emit much less RF energy than cell phones.
- Send text messages instead of talking on the phone.
- If you are streaming video or if you are downloading or sending large files, try to keep the phone away from your head and body.
- Carry your cell phone in a backpack, briefcase, or purse NOT in a pocket, bra, or belt holder. Because your phone’s antenna is to stay connected with a cell tower wherever it’s on, it emits some RF energy even when you are not using it. It does not emit RF energy when it’s in airplane mode. (Airplane mode turns off cellular, WiFi, and Bluetooth.)
- Reduce or avoid using your cell phone when it is sounding high levels of RF energy. This happens mainly when:
  - You use only one or two bars displayed. Cell phones put out more RF energy to connect with cell towers when the signal is weak. You must use your phone when the signal is weak, try to follow the other guidance on this page.
  - You are in a fast-moving car, bus, or train. Your phone puts out more RF energy to maintain connections to avoid dropping calls as it switches connections between cell towers to the next unless it’s in airplane mode.
  - You are streaming audio or video, downloading or sending large files. To watch movies or listen to podcasts on your phone, download them first, then switch to airplane mode while you watch or listen.
- Don’t sleep with your phone in your bed or near your head. Unless the phone is off or in airplane mode, keep it at least a few feet away from your bed.
- Talk off the headset when you’re not on a call. Headsets release small amounts of RF energy even when you are not using your phone.

What about children?

Children may be more at risk from wireless devices because:

- RF energy can reach a larger area of the head/brain in younger children.
- A child’s brain and body are growing and developing through the teen years. During this time, the body may be more easily affected by RF energy and the effects may be more harmful and lingering.
- A child who uses a cell phone will have many more years of exposure to RF energy in his or her lifetime than someone who started using a cell phone as an adult.

There is not a lot of research about the effects of cell phone RF energy on children or teenagers, but a few studies have shown that there may be hearing loss or ringing in the ears, headaches, and decreased general well-being.

CDPH cell phone safety guidance

Don’t keep a “child’s device” or other products containing RF energy in your refrigerator. Refrigerators are made of metal, so they can absorb and concentrate RF energy, which might increase the level of RF energy in or near the device.

For more information, please visit these websites:

- Centers for Disease Control and Prevention
- *EMF Health and Safety Foundation*
- *Federal Communications Commission (FCC)*
- *World Health Organization*
- *American Academy of Pediatrics*
- *California Department of Public Health*
5G: Latest threat to population & environmental health

- **Electromagnetic Radiation Safety**
  - Scientists and doctors demand moratorium on 5G
  - Is 5G harmful to our health?
  - Millimeter wave health effects
  - Cutting through the hype
  - Newspaper editorials oppose "small cell" antenna bills

- **Physicians for Safe Technology**
- **Environmental Health Trust**
5G: Scientists & doctors call for moratorium on deployment

- Moratorium on roll-out of 5th generation cellular technology
- 2017: Submitted to European Commission
- Signed by >200 scientists & physicians
  - 38 nations

www.5gappeal.eu
5G: International Society of Doctors for the Environment Appeal

“5G networks in European Countries: Appeal for a standstill in the respect of the precautionary principle.” Apr 2018.

http://www.isde.org/5G_appeal.pdf
Emerging wireless technologies

- 5G (5th generation cellular technology)
- Internet of Things (IoT)
  - Smart appliances, TVs, thermostats, etc.
- Smart cities
- Autonomous motor vehicles
- Wearable wireless devices
  - Watches, glasses, ear buds, medical implants, etc.
National Institute for Science, Law & Public Policy (NISLAPP) recommends:

“Re-Inventing Wires: The Future of Landlines and Networks”
by Timothy Schoechle, PhD

Learn 13 ways “fiber to the premises” - rather than 4G/5G wireless antennas - strengthens U.S. communications, national security and the economy.

“Fiber to the Premises” improves:

1. Speed of Internet access
2. Neutrality of Internet access
3. Quality of voice communication
4. Reliability
5. Energy usage and efficiency
6. Resiliency in extreme weather events
7. Value for the money to all users
8. Safety and cybersecurity
9. Personal privacy
10. Public health
11. The biological ecosystem
12. Landline phone access when the power goes out, and
13. The integrity of the communications system as a whole, which has become hijacked by commercial motivations and riddled with planned obsolescence and unnecessary future costs for us all.

All of these factors are important to constituents and our future.

Advanced Copper and Optical Fiber are Far Superior to Wireless in Both Cost and Performance.

Read “Re-Inventing Wires: The Future of Landlines and Networks” and the “10 Recommendations for Communities and Policymakers”:
https://tinyurl.com/y89sfng8
My concluding thoughts

We are guinea pigs in a massive technological experiment that threatens our health. Our government needs to determine what constitutes a safe level of long-term exposure to wireless radiation and strengthen the FCC's radio frequency exposure guidelines. In the meantime, the government should impose a moratorium on technologies that increase our exposure to wireless radiation, especially new forms of wireless radiation like 5G cellphone radiation.

NTP Cell Phone Radiation Study: Final Reports
References

References for this presentation are available at:

Contact information

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Saferemr.com
Supplementary Slides

- PEAK OIL
- FOOD SUPPLY
- CELL PHONE RADIATION
- OZONE HOLES!
- MELTING ICE CAPS
- A PANDEMIC IS COMING SOON!
- THE END IS NIGH
- BIRD FLU!
- ANTIBIOTIC RESISTANCE
Risk of glioma from wireless phone use (Hardell, 2013)
Hardell research group: Case-control studies since IARC

- Wireless phone use 25+ years
  - Glioma: $\text{OR} = 3.3$ (95% CI: 1.6 – 6.9)

- Wireless phone use 20+ years
  - Acoustic neuroma: $\text{OR} = 4.4$ (95% CI: 2.2 – 9.0)

U.S. - increases in brain tumor incidence over time

- Glioma in frontal lobe in adults 20 - 29 years old
- GBM in frontal & temporal lobes & cerebellum (overall population)
- Malignant brain & central nervous system tumors among children (0 - 14 years old)
- Non-malignant meningioma & pituitary tumors among children, adolescents & young adults (0 - 39 years old)

Other nations - increases in brain cancer incidence over time

- **Netherlands, Norway & Finland**: overall
- **Australia & New Zealand**: over age 70
- **Sweden**: overall increase in inpatient registry but not tumor registry
- **England**: frontal & temporal lobes overall; GBM (glioblastoma) overall
- **Netherlands, Denmark, Australia**: GBM overall
Biological mechanisms

• Pall (2013) review paper
  – ELF & RF stimulate voltage-gated calcium channels to increase intra-cellular calcium ions & nitric oxide synthesis
  – Calcium channel blockers eliminate EMF-induced effects (23 studies)

• Leif Salford - blood-brain barrier penetration

• Other mechanisms
Yakymenko et al. (2015) review

- Oxidative stress = imbalance between free radical production & body’s ability to counteract harmful effects via antioxidants
- Effects = disrupted cell signaling, stress proteins, free radical formation, DNA-damage → carcinogenicity, neurologic disorders (e.g., electrosensitivity, ADHD)
- 93 of 100 studies (73 animal/plant, 16 cell samples, 4 human studies) → significant evidence of oxidative stress
Three-fourths of studies find significant biologic effects

Results of 537 Biologic Studies of the Effects of Radiofrequency Radiation Exposure
Dr. Henry Lai, University of Washington

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of Studies w/ Significant Effects</th>
<th>Number of Studies w/ No Significant Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic</td>
<td>170 (71%)</td>
<td>71 (29%)</td>
</tr>
<tr>
<td>Genetic</td>
<td>84 (66%)</td>
<td>41 (34%)</td>
</tr>
<tr>
<td>Free Radical</td>
<td>152 (89%)</td>
<td>19 (11%)</td>
</tr>
<tr>
<td>Overall</td>
<td>406 (76%)</td>
<td>131 (24%)</td>
</tr>
</tbody>
</table>
Early research results varied by funding source

<table>
<thead>
<tr>
<th>Funding</th>
<th>Effect</th>
<th>No Effect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>27 (32%)</td>
<td>57 (68%)</td>
<td>84</td>
</tr>
<tr>
<td>Non-industry</td>
<td>96 (70%)</td>
<td>41 (30%)</td>
<td>137</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>123 (56%)</strong></td>
<td><strong>98 (44%)</strong></td>
<td><strong>221</strong></td>
</tr>
</tbody>
</table>

\[ X^2 = 28.83 \ (p<.001) \ (1/27/05) \]

(Compiled by Prof. Henry Lai, Univ. Washington)
U.S. - Major cell phone radiation studies

- **1993** – Wireless industry (CTIA) funded 7-year, $28 million project
  - FDA co-sponsored study but dropped out
  - No peer-reviewed results published

- **1999** – FDA proposed $10 million project
  - Study effects of 2G cell phone radiation on mice & rats
  - 2005 – Study initiated by National Toxicology Program
  - 2016 – Partial results released
  - 2018 – Final results released
  - $30 million cost
Cell Phone in Airplane Mode & Disable WiFi

Due to a patron medical condition, please put your cell phone in Airplane Mode and disable WiFi.

www.kfpl.ca
Precautionary principle

“Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

European Union: Policy recommendations

- **Governments**: adopt more stringent radiation standards & fund research ([European Environment Agency](http://eea.europa.eu), 2011)
- **Manufacturers**: improve cell phone design & issue warning labels (EEA, 2011)
- **Consumers**: reduce exposure (especially children); hands-free use (EEA, 2011)
- **Schools**: restrict Wi-Fi & mobile phone use ([Council of Europe](http://conrep.coe.int), 2011)
The existing exposure guidelines are based on protection from acute injury from thermal effects of radiofrequency radiation exposure, and may not be protective against any non-thermal effects of chronic exposure.

“A significant research effort is needed… to provide the basis to assess the risk to human health of wireless communications devices.”

http://1.usa.gov/1Mzz6UM
– Cell-phone manufacturers should prominently display advice on how to reduce cell-phone radiation exposure.

Massachusetts: Pending wireless safety legislation

- **S.107** Provide RF notifications on wireless devices
- **S.108** Disclose safe use of handheld devices by children on product packaging
- **S.1268** Commission to examine EMF health impacts
- **S.1864** Allow consumers to retain non-wireless radiation-emitting meters at no-cost
- **H.2030** Wireless management practices in public schools & colleges
- **S.2079** Reduce EMF exposure in schools
- **S.2080** Increase medical awareness & insurance coverage of non-ionizing radiation injuries
## RF exposure limits

### International Radio Frequency "RF" Exposure Limits for 1800 MHz Range

<table>
<thead>
<tr>
<th>Location</th>
<th>Reference</th>
<th>Exposure time</th>
<th>Limit Based On</th>
<th>Lower by</th>
<th>μW/m²</th>
<th>V/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most of Western Europe</td>
<td>IEEE C95.1-1999 and ICNIRP</td>
<td>30 minutes</td>
<td>Thermal / Heating</td>
<td>-</td>
<td>10,000,000</td>
<td>61.4</td>
</tr>
<tr>
<td>USA</td>
<td>(FCC) IEEE C95.1-1999 and ICNIRP</td>
<td>30 minutes</td>
<td>Thermal / Heating</td>
<td>-</td>
<td>10,000,000</td>
<td>61.4</td>
</tr>
<tr>
<td>Canada</td>
<td>Safety Code 6, Table 5 (2015)</td>
<td>6 minutes</td>
<td>Thermal / Heating</td>
<td>66 x</td>
<td>4,393,278.4</td>
<td>40.7</td>
</tr>
<tr>
<td>Russia</td>
<td>Sanitary Norms and Regulations 2.2.4/2.1.8.055-96</td>
<td>3 hours +</td>
<td>Biological Effects</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>China</td>
<td>UDC 614.898.5 GB 9175 –88</td>
<td>3 hours +</td>
<td>Biological Effects</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>Italy</td>
<td>Sanitary Norms and Regulations 2.2.4/2.1.8.055-96</td>
<td>3 hours +</td>
<td>Biological Effects</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>Most of Eastern Europe</td>
<td>Sanitary Norms and Regulations 2.2.4/2.1.8.055-96</td>
<td>3 hours +</td>
<td>Biological Effects</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Ordinance on Protection from Non-ionising Radiation (NISV)</td>
<td>Long Term</td>
<td>Precautionary</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>Toronto Board of Health, Canada</td>
<td>Proposed 1999</td>
<td>Long Term</td>
<td>Precautionary</td>
<td>100 x</td>
<td>100,000</td>
<td>6.14</td>
</tr>
<tr>
<td>Bio-Initiative Report recommendation</td>
<td>Bio-Initiative Report 2007</td>
<td>Long Term</td>
<td>Biological / Precautionary</td>
<td>10,000 x</td>
<td>1,000</td>
<td>0.614</td>
</tr>
<tr>
<td>Salzburg Resolution on Mobile Telecommunication</td>
<td>Preventive public health protection, Salzburg, June 7-8, 2000</td>
<td>Long Term</td>
<td>Precautionary</td>
<td>10,000 x</td>
<td>1,000</td>
<td>0.614</td>
</tr>
<tr>
<td>European Parliament</td>
<td>Resolution 1815, Strasbourg, May 27, 2011</td>
<td>Long Term</td>
<td>Precautionary</td>
<td>10,000 x</td>
<td>106</td>
<td>0.2</td>
</tr>
<tr>
<td>Building Biology Guidelines Germany (Sleeping Areas)</td>
<td>SBM2008 - Level of No Biological Concern</td>
<td>Long Term</td>
<td>Precautionary</td>
<td>100,000,000 x</td>
<td>0.1</td>
<td>0.006,14</td>
</tr>
<tr>
<td>Cell Phone Operational Requirements</td>
<td></td>
<td></td>
<td></td>
<td>10,000,000,000 x</td>
<td>0.001</td>
<td>0.000,061,4</td>
</tr>
<tr>
<td>Natural Cosmic Radiation</td>
<td>MAES 2000</td>
<td>Long Term</td>
<td>Natural Exposure</td>
<td>10,000,000,000,000 x</td>
<td>0.000,001</td>
<td>0.000,000,061,4</td>
</tr>
<tr>
<td>Average Indoor Urban Exposure Toronto, Canada</td>
<td>Safe Living Technologies Inc. 2011</td>
<td>Long Term</td>
<td></td>
<td>200 - 5000</td>
<td>0.3 - 1.4</td>
<td></td>
</tr>
</tbody>
</table>
How to Reduce Exposure to Radiofrequency Energy from Cell Phones

How can you reduce your exposure?
Keep your phone away from your body. Keeping your phone just a few feet away from you can make a big difference.

- When you talk on your cell phone, avoid holding it to your head—use the speakerphone or a headset instead. Wireless (Bluetooth) and wired headsets emit much less RF energy than cell phones.
- Send text messages instead of talking on the phone.
- If you are streaming or if you are downloading or sending large files, try to keep the phone away from your head and body.
- Carry your cell phone in a backpack, briefcase, or purse; not in a pocket, bra or belt holder. Because your phone's antenna tries to stay connected with a cell tower whenever it's on, it emits some RF energy even when you are not using it. It does not emit RF energy when it's in airplane mode (Airplane mode turns off cellular, Wi-Fi, and Bluetooth).

Reduce or avoid using your cell phone when it is sending out high levels of RF energy. This happens mainly when:
- You see only one or two bars displayed. Cell phones put out more RF energy to connect with cell towers when the signal is weak. If you must use your phone when the signal is weak, try to follow the other guidance on this page.
- You are in a fast-moving car, bus, or train. Your phone puts out more RF energy to maintain connections to avoid dropping calls as it switches connections from one cell tower to the next unless it is in airplane mode.
- You are streaming audio or video, or downloading or sending large files. To watch movies or listen to playlists on your phone, download them first, then switch to airplane mode while you watch or listen.

Don't sleep with your phone in your bed or near your head. Unless the phone is off or in airplane mode, keep it at least a few feet away from your bed.

Take off the headset when you're not on a call. Headsets release small amounts of RF energy even when you are not using your phone.


What about children?
Children may be more at risk for harm from exposure to RF energy because:
- RF energy can travel a longer way than an adult's brain.
- A child's brain and body grow and develop through the teen years. During this time, the body may be more easily affected by RF energy and the effects may be more harmful and longer lasting.
- A child who uses a cell phone will have more years of exposure to RF energy in his or her lifetime than someone who started using a cell phone as an adult.

There is not a lot of research about the effects of cell phone RF energy on children or teenagers, but a few studies have shown that there may be hearing loss or ringing in the ears, headaches, and decreased general well-being.

Reducing Exposure: Hands-free Kits and Other Accessories

Steps to reduce exposure to radiofrequency energy

If there is a risk from being exposed to radiofrequency energy (RF) from cell phones—and at this point we do not know that there is—it is probably very small. But if you are concerned about avoiding even potential risks, you can take a few simple steps to minimize your RF exposure.

- Reduce the amount of time spent using your cell phone
- Use speaker mode or a headset to place more distance between your head and the cell phone.

Hands-free kits

Hand-free kits may include audio or Bluetooth headsets and various types of body-worn accessories such as belt-clips and holsters. Combinations of these can be used to reduce RF energy absorption from cell phone.

Headsets can substantially reduce exposure since the phone is held away from the head in the user’s hand or in approved body-worn accessories. Cell phones marketed in the U.S. are required to meet RF exposure compliance requirements when used against the head and against the body.

Since there are no known risks from exposure to RF emissions from cell phones, there is no reason to believe that hands-free kits reduce risks. Hands-free kits can be used for convenience and comfort. They are also required by law in many states if you want to use your phone while driving.

Cell phone accessories that claim to shield the head from RF radiation

Since there are no known risks from exposure to RF emissions from cell phones, there is no reason to believe that accessories that claim to shield the head from those emissions reduce risks. Some products that claim to shield the user from RF absorption use special phone cases, while others involve nothing more than a metallic accessory attached to the phone. Studies have shown that these products generally do not work as advertised. Unlike "hands-free" kits, these so-called "shields" may interfere with proper operation of the phone. The phone may be forced to boost its power to compensate, leading to an increase in RF absorption.
CDC safety tips

Radiation and Your Health

If you are worried about cell phone use, follow the tips below.

Cell phone tips

To reduce radio frequency radiation near your body:

- Get a hands-free headset that connects directly to your phone.
- Use speaker-phone more often.
- In the past, RF interfered with the operation of some pacemakers. If you have a pacemaker and are concerned about how your cell phone use may affect it, contact your health care provider.
What can cell phone users do to reduce their exposure to radiofrequency radiation?

The FDA has suggested some steps that concerned cell phone users can take to reduce their exposure to radiofrequency radiation (49):

- Reserve the use of cell phones for shorter conversations or for times when a landline phone is not available.
- Use a device with hands-free technology, such as wired headsets, which place more distance between the phone and the head of the user.

Hands-free kits reduce the amount of radiofrequency radiation exposure to the head because the antenna, which is the source of energy, is not placed against the head (40). Exposures decline dramatically when cell phones are used hands-free.

Does Cell Phone Use Cause Brain Cancer? What the New Study Means For You

Specifically, Consumer Reports recommends that you:

- Try to keep the cell phone away from your head and body. Keeping it an arm’s distance away significantly reduces exposure to the low-level radiation it emits. This is particularly important when the cellular signal is weak—when your phone has only one bar, for example—because phones may increase their power then to compensate.

- Text or video call when possible, because this allows you to hold the phone farther from your body.

- When speaking, use the speakerphone on your device or a hands-free headset.

- Don’t stow your phone in your pants or shirt pocket. Instead, carry it in a bag or use a belt clip.
Documentary Films

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(2017)