

A 5G Wireless Future: Will it give us a Smart Nation or contribute to an Unhealthy One?

Dr. Cindy Russell

SCCMA V.P. Community health

“It would greatly extend FCC’s current policy of the mandatory irradiation of the public without adequate prior study of the potential health impact and assurance of safety. It would irradiate everyone, including the most vulnerable to harm from radiofrequency radiation: pregnant women, unborn children, young children, teenagers, men of reproductive age, the elderly, the disabled, and the chronically ill.” —Ronald Powell, PhD, Letter to FCC on 5G expansion (7)

BRAVE NEW WORLD OF COMMUNICATION

The use of mobile wireless technologies continues to increase worldwide. A new faster 5th generation (5G) telecommunication system has recently been approved by the Federal Communications Commission(FCC) with new antennas already being installed and tested in Palo Alto and Mountain View. While it may give us uber automation and instantaneous “immersive entertainment” a lot of questions remain with regards to public health and safety of wireless devices. Will the adoption of this new 5G technology harm directly or indirectly the consumers and businesses it hopes to attract?

5G is the new promised land for wireless technology. It could connect us in our homes, workplaces and city streets to over a trillion objects around the world. (96) The Internet of Things (IoT) is primed to give us self-driving cars, appliances that can order their own laundry soap, automation hubs that pay your bills, not to mention fast movie downloads and virtual reality streaming from anywhere when you are on the go. Companies are already asking local cities and counties to move forward to create “Smart Cities” which have comprehensive digital connectivity by installing a massive wireless sensor network of almost invisible small cell antennae


on light posts, utility poles, homes and businesses throughout neighborhoods and towns in order to integrate IoT with IT. They state it will improve services, the economy and quality of life. This communication network will form an expanded electromagnetic microwave blanket above each city and county, permeating the airspace and providing seamless connectivity where people and things will exchange data.


Former Federal Communications Commission (FCC) chair Tom Wheeler called this a “National Priority” and thus ushered in approval for the addition of this new pervasive network of high frequency short wave millimeter broadband for commercial use first planned in urban areas.

Developing a “Smart” World?

Engineers and physicists are busy working out the details of carrier frequencies and the architecture of the new network. Manufacturing industries are already developing commonly used products that feature wireless integration that will connect to the densely clustered antennas. Marketing companies are now pushing ads for “smart” devices for “smart” people in “smart” cities. Even the healthcare industry is anticipating using some of these wearable devices for patients with cardiac conditions or to do remote surgery in other parts of the world. Opening up 5G Spectrum access hopes to drive an explosion of new products. The economic opportunities are obvious and business will be booming in the tech industry.

Concerns continue to rise however about the basic safety of our current use of wireless technologies not to mention adding layers of newer microwave frequencies that have not been tested for short term or long term safety. Important questions have not been addressed while industry and government policy have already moved forward.

 Why is the FCC streamlining permitting of 5G high frequency when they have not completed their investigation on health effects nor updated safety limits for low-intensity radio frequency radiation?

 Is the widespread “deployment” of this pervasive higher frequency small cell distributed antennae system in our cities and on our homes safe for humans and the environment?

Will it add to the burden of chronic disease that costs our nation over a trillion dollars annually? (105)

Are we already digitally over connected, outsourcing our grey matter and becoming a dysfunctional addicted nation because of it? (136,137,138)

How will this affect our privacy, cyber security and the security of medical records?

Will we as physicians be able to recognize the emerging adverse health effects of new millimeter technology and wearable technology let alone that of current wireless devices?

Over the past century, this natural environment has sharply changed with introduction of a vast and growing spectrum of man-made EM fields.” Adey (135)

A Good Read: Federal Communications Commission 5G Letters

Letters to the FCC in 2016 responding to the 5G roll out with the addition of new high frequencies were mixed. Industry generally applauded the FCC for its efforts and discussed the growing demand for this technology along with a need for flexible regulation to implement it. Some expressed concerns about interference with other satellite systems. Some felt there should be maximum spectrum usage opening up even higher frequencies that are only experimental now in order to help “the underserved”. Others argued about opening this up to licensed versus unlicensed uses. Industry did not mention any potential public or environmental health hazards regarding the use of these new frequencies.

Raising a Red Flag to Push the Pause Button on 5G

Private citizens and Phd's, however did raise a red flag at the FCC, recommending a halt to infrastructure plans and more testing for health and environmental reasons. They questioned the current FCC standards which are outdated and not protective of human health. They asked "How will it affect children, pregnant women and the elderly who are the most vulnerable in our population?" While scientists gave ample evidence that precaution should prevail, I found the most compelling letters were from those who describe their fear as electro-sensitive people in an already dangerously high electromagnetic environment for them.

Gimme Shelter: No Escape for Electro-Sensitive Individuals

Linda K., a Michigan resident, explained how she became increasingly sensitive to EMF after a cell tower was placed within 1000 feet of her house.

She experienced insomnia at first and did not know there was a cell tower until several years later when she then associated the timing of its placement with her symptoms. After smart meters were installed in her area (but not on her house) she became sensitive to her laptop on wireless and her cell phone. Comcast then placed a Wi-Fi hotspot within 400 feet of her house and she stated her symptoms increased to the point that if she was outside in her yard more than 20 minutes she developed increasing fatigue, headaches, heart palpitations and high pitched ringing in her ears. These are all reported effects in those sensitive to EMF from wireless devices. She wrote about her concerns and that the new frequencies may add to her symptoms and inability to leave her house. (54)

In another letter Veronica Z. noted "This is a notice of survival. What many of us deal with currently is trying to survive in an environment that is hostile to us biologically. We have lost all of our rights, our finances, our homes, our ability to earn a living due to this ubiquitous exposure. We are being tortured every second of every day and have been reduced to simply trying to survive the moments we are alive. Others have been unable to do so and have opted to not stay living on this planet of torture...There is no escape for people with severe sensitivities to this deadly radiation." (55)

Ask NASA: Is Electro-Sensitivity Real or Imagined?

Are these people telling the truth? Is this just psychological? You may wonder, however, more and more people from all ages, professions and walks of life are relating similar symptoms in the presence of wireless devices. Some children reported these symptoms when their school adopted WiFi.

Dr. Scott Eberle, a well respected Petaluma hospice physician, eloquently described his development of electro-sensitivity in the November 2016 issue of the SCCMA Bulletin. He goes to great lengths to continue his profession, interact with his colleagues and maintain a healthy existence. (67)

We are exposed to increasing levels of microwave EMF in our daily lives. More scientific evidence links biologic effects with increased reports of health related effects including electrosensitivity. In 1971 Russian scientists Gordon and Sadchikova from the Institute of Labor Hygiene and Occupational Diseases described a comprehensive series of symptoms which they called ‘microwave sickness’ and presented this at an international WHO meeting. (109)

In a 1981 NASA report, “Electromagnetic Field Interactions: Observed Effects and Theories” microwave sickness was also described. The symptoms recorded were headaches, eyestrain, fatigue, dizziness, disturbed sleep at night, sleepiness in daytime, moodiness, irritability, unsociability, hypochondriac reactions, feelings of fear, nervous tension, mental depression, memory impairment, pulling sensation in the scalp and brow, loss of hair, pain in muscles and heart region, breathing difficulties, increased perspiration of extremities. (63)

The Science of Electro-Sensitivity

Belpomme, in 2015, completed the most comprehensive study of electrosensitivity, investigating 1216 people: 71.6% with EHS, 7.2% with CS, and 21.2% with both. They found an elevation in several reliable disease biomarkers—each occurring within a range of 23% to 40% of all cases—which prompted their conclusion that these sensitivities can be objectively characterized and diagnosed and “appear to involve inflammation-related hyper-histaminemia, oxidative stress, autoimmune response, capsulothalamic hypoperfusion and pathologic leakage of the blood-brain barrier, and a deficit in melatonin metabolic availability” (68)

The Science of EMF Biological Harm

The scientific literature abounds with evidence of non-thermal cellular damage from non-ionizing wireless radiation for several decades. There are likely several mechanisms both direct and indirect. Oxidative damage is one that has been well studied. Effects have been demonstrated on cell membranes causing a shift in the voltage gated calcium channels. Sperm studies have consistently found genotoxic, morphologic and motility abnormalities in the presence of cell phone radiation. DNA damage, blood brain barrier effects, melatonin reduction, nerve cell damage, mitochondrial disruption and memory disturbances have been revealed. The Bioinitiative Report (139) has chronicled these effects and a growing wave of PEER reviewed studies is building on that base daily. In 2011, the International Agency for Research on Cancer classified radiofrequency as 2B carcinogen and “possibly carcinogenic to humans”, the same category as DDT, lead and other pesticides

The Latest Science: National Toxicology Program Study on Cell Phones and Cancer

The most recent and compelling evidence has come from the 2016 National Institutes of Health, National Toxicology Program. Called the NTP Toxicology and Carcinogenicity Cell Phone Radiation Study, the 10 year \$25 million research revealed conclusively that there was a harmful effect from cell phone microwave radiation. (124,125) The frequencies are similar to other wireless devices we commonly use. The studies were robust, collaborative, well controlled and with double the number of rats required to reveal a significant effect, if present. The preliminary results of the study showed that RFR caused a statistically significant increase in two types of brain tumors, gliomas and schwannomas. These were the same two types of tumors shown to increase in human epidemiological studies on long term use of cell phones. Dr. Lennart Hardell and others have demonstrated a consistent pattern of increased incidence of ipsilateral (same side) acoustic neuromas (vestibular schwannomas) and gliomas with each 100 hours of cell phone use. (112-118) Another telling finding was that the control rats had much lower than expected cancer rates. It is believed due to the fact the control rats were in a controlled faraday cage and not exposed to normal ambient EMF that could contribute to cancer.

Ron Melnik, PhD, Senior Toxicologist and Director of Special Programs in the Environmental Toxicology Program at the National Institute of Environmental Health Sciences (NIEHS) and designer of the study states, "The NTP tested the hypothesis that cell phone radiation could not cause health effects and that hypothesis has now been disproved. The experiment has been done and, after extensive reviews, the consensus is that there was a carcinogenic effect." (124,125,126,127)

Health Effects of Millimeter 5G Wavelengths

The term "millimeter waves" (MMW) refers to extremely high-frequency (30-300 GHz) electromagnetic radiation. Millimeter Waves (MMW) used in the next-generation of high-speed wireless technologies have shallow penetration thus effect the skin surface, the surface of the eye or on bacteria, plants and small life forms. Surface effects, however, can be quite substantial on an organism as stimulation of skin receptors can affect nerve signaling causing a whole body response with physiological effects on heart rate, heart rhythm, and the immune system.

In a 1998 review article, Pakhomov (123) looked at the bio-effects of millimeter waves. He reviewed dozens of studies and cites research demonstrating profound effects of MMW on all biological systems including cells, bacteria, yeast, animals and humans. Some effects were clearly thermal as millimeter microwaves are rapidly absorbed by water which is abundant in living organisms. When microwaves are absorbed the energy can cause tissue heating. Many of the millimeter frequency studies however showed effects without heating of tissues and at low intensities. Research was variable and showed both regenerative effects and also adverse effects depending on frequency, power and exposure time.

Arrythmias

Chernyakov induced heart rate changes in anesthetized frogs by microwave irradiation of remote skin areas. Complete denervation of the heart did not prevent the reaction. This suggested a reflex mechanism of the MMW action involving certain peripheral receptors.(28)

Heart Rate Variability

Potekhina found certain frequencies from 53-78 GHz band (CW) changed the natural heart rate variability in anesthetized rats. He showed that some frequencies had no effect (61 or 75 GHz) while other frequencies (55 and 73 GHz) caused pronounced arrhythmia. There was no change in skin or whole body temperature. (69)

Teratogenic Effects

One study of MMW teratogenic effects was performed in *Drosophila* flies by Belyaev. Embryos were exposed to 3 different GHz frequencies for 4-4.5 hours at 0.1 mW/cm². He found that irradiation at 46.35 GHz, but not at 46.42 or 46.50 GHz, caused marked effects including an increase in morphological abnormalities and decreased survival. It was felt the MMW disturbed DNA-protein interactions at that particular frequency. (65)

Bacterial Affects and Antibiotic Resistance

Bulgakova in over 1,000 studies with 14 different antibiotics showed how MMW exposure of *S. aureus* affects its sensitivity to antibiotics with different mechanisms of action. The MMW increased or decreased antibiotic sensitivity depending on the antibiotic concentration. (134)

Pakhomov warns, **“Regardless of the primary mechanism, the possibility of significant bio-effects of a short-term MMW irradiation at intensities at or below current safety standards deserves consideration and further study. The possibility of induction of adverse health effects by a local, low-intensity MMW irradiation is of potential significance for setting health and safety standards and requires special attention.”** He called for replication of studies especially long term effects of MMW.

His conclusions

- 1) Individuals or groups in a population, which would usually be regarded as uniform, may react to MMW in rather different or even opposite ways
- 2) There seem to exist unknown and uncontrolled factors that determine the MMW sensitivity of a specimen or a population. Irradiation could increase antibiotic resistivity in one experiment and decrease it in the next one
- 3) Increased sensitivity and even hypersensitivity of individuals to MMW may be real. Depending on the exposure characteristics, especially wavelength, a low-intensity MMW radiation was perceived by 30 to 80% of healthy examinees (123)

Cataracts

Prost in 1994 studied millimeter microwave radiation on the eye. He noted that microwaves of different wave-lengths can induce the development of cataracts. (13) His research found that low power millimeter waves produced lens opacity in rats exposed to 10mW/cm², a predisposing indicator of cataracts.(74)

Immune System

Kolomytseva, in 2002, looked at the dynamics of leukocyte number and functional activity of peripheral blood neutrophils under whole-body exposure of healthy mice to low-intensity extremely-high-frequency electromagnetic radiation (EHF EMR, 42.0 GHz, 0.15 mW/cm², 20 min daily).The study showed that the phagocytic activity of peripheral blood neutrophils was suppressed by about 50% in 2-3 h after a single exposure to EHF EMR.(131)

Chromatin Effects

Gapeve in 2003 showed for the first time that low-intensity extremely high-frequency MMH electromagnetic radiation in vivo causes effects on spatial organization of chromatin in cells of lymphoid organs. Chromatin is a complex of DNA and proteins that forms chromosomes within the nucleus of eukaryotic cells. He exposed mice to a single whole-body exposure for 20 min at 42.0 GHz and 0.15 mW/cm². (132)

Gene Expression

Habauzit in 2013 looked at gene expression in keratinocytes with 60GHz exposure at upper limit of current guidelines and concluded “In our experimental design, the high number of modified genes (665) shows that the ICNIRP current limit is probably too permissive to prevent biological response. (73)

Gaps in Data for Launching 5G millimeter devices

Commercial production often precedes research on consumer protection and health effects. We have too many toxins that have escaped premarket safety protocols for too long- lead, asbestos, smoking and our modern unregulated nanoparticles to mention just a few. These affect our long term and short term health in ways we do not even know. If we become ill, we do not question or identify the daily or weekly chemical exposures that could have contributed to that cancer or arthritis or lung disease or Alzheimer’s. We have too many toxins to sort it all out.

Research shows that wireless microwave radiation adds yet another dose of toxic exposure to our daily lives. We cannot hear it or smell it or feel it. Yet it affects our biology and our wellbeing with perhaps subtle affects. If we are electro-sensitive then we are more likely to avoid exposure. Trees are even susceptible to EMF harm and they cannot move away. (128) What about birds and bees and us?

Close Encounters: Google Glass, Virtual Reality and Wearable Wireless Devices

If we are concerned about putting a cell phone to our ears for long periods of time after reading about the NTP study then why aren’t we concerned about other wearable devices? While very cool to use Google Glass and Virtual Reality may have dangerous consequences to our eyes, brain function or immune systems with long term use, especially to children. What are the frequencies in these

devices? 3G,4G, 5G or a combination of zapping frequencies giving us immersive connection and entertainment but at a potentially steep price.

5G Research and Policy

Safety testing for 5G is the same as other wireless devices. It is based on heat. This is an obsolete standard and not considering current science showing cellular and organism harm from non-thermal effects. There is a large gap in safety data for 5G biological effects that has been demonstrated in older studies including military.

New Recommendations to Protect Public Health

- 1) Do not proceed to roll out 5G technologies pending pre-market studies on health effects**
- 2) Reevaluate safety standards based on long term as well as short term studies on biological effects**
- 3) Rescind a portion of Section 704 of the Telecommunications Act of 1996 which preempts state and local government regulation for the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects so that health and environmental issues can be addressed**
- 4) Rescind portions of The Spectrum Act which was passed in 2012 as part of the Middle Class Tax Relief and Job Creation Act, which strips the ability city officials and local governments to regulate cellular communications equipment, provides no public notification or opportunity for public input and may potentially result in environmental impacts**
- 5) Create an independent multidisciplinary scientific agency tasked with developing appropriate safety regulations, premarket testing and research needs in a transparent environment with public input**

6) Label pertinent EMF information on devices along with appropriate precautionary warnings.

References for:

A 5G Wireless Future: Will it give us a Smart Nation or contribute to an Unhealthy One?

1) **Project Skybender: Google's secretive 5G internet drone tests revealed.** The Guardian. Mark Harris. January 29, 2016.

<https://www.theguardian.com/technology/2016/jan/29/project-skybender-google-drone-tests-internet-spaceport-virgin-galactic>

2) **Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies .** October 17,

2014. https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-153A1.pdf

3) **Use of Spectrum Bands Above 24 GHz For Mobile Radio Services.** October 22, 2015. https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-138A1.pdf

4) **5G Spectrum.**

http://www.4gamericas.org/files/6514/3930/9262/4G_Americas_5G_Spectrum_Recommendations_White_Paper.pdf

5) **FCC Comments. Ronald Powell, PhD.** Applied Physics Degree-Harvard University. August 31, 2013. <https://ecfsapi.fcc.gov/file/7520940670.pdf>

6) **Message to Schools and Colleges about Wireless Devices and Health.** Ronald Powell, PhD. Nov 24, 2015. <https://www.scribd.com/document/289778053/Message-to-Schools-and-Colleges-about-Wireless-Devices-and-Health>

7) **FCC Letter Opposition to Development of Spectrum Frontiers 5G.** Derek Bishop for Ronald Powell, PhD. <https://www.fcc.gov/ecfs/filing/107132543307627>

8) **Small cells: Backhaul difficulties and a 5G future**

<http://www.rcrwireless.com/20160711/network-infrastructure/small-cells-tag31-tag99>

9) **Non-line-of-sight microwave backhaul for small cells.** https://www.ericsson.com/res/thecompany/docs/publications/ericsson_review/2013/er-nlos-microwave-backhaul.pdf

10) **Frequency Wavelength Chart- Henry Ott Consultants.** <http://www.hottconsultants.com/techtips/freq-wavelength.html>

11) **Convert Gigahertz to centimeter wavelengths.** http://www.translatorscafe.com/cafe/EN/units-converter/frequency-wavelength/5-29/gigahertz-wavelength_in_centimetres/

12) **What is 2 G Spectrum? Graph of Electromagnetic spectrum.** <https://www.quora.com/What-is-2G-spectrum>

13) **Electromagnetic radiation. U of Oregon** http://abyss.uoregon.edu/~js/glossary/electromagnetic_radiation.html

14) **Bees Can Sense the Electric Fields of Flowers.** <http://phenomena.nationalgeographic.com/2013/02/21/bees-can-sense-the-electric-fields-of-flowers/>

15) **Detection and Learning of Floral Electric Fields by Bumblebees.** Clarke, Whitney, Sutton & Robert Science. <http://dx.doi.org/10.1126/science.1230883>

16) **Dolphin detects electric fields with ex-whisker pits.** <http://phenomena.nationalgeographic.com/2011/07/26/dolphin-detects-electric-fields-with-ex-whisker-pits/>

17) **The electromagnetic response of human skin in the millimetre and submillimetre wave range.** Feldman, Y. Phys Med Biol. 2009 Jun 7;54(11):3341-63 <https://www.ncbi.nlm.nih.gov/pubmed/?term=19430110>

18) **Human skin as arrays of helical antennas in the millimeter and submillimeter wave range.** Feldman, Y. Phys Rev Lett. 2008 Mar 28;100(12):128102 <https://www.ncbi.nlm.nih.gov/pubmed/18517913>

19) **Human skin as arrays of helical antennas in the millimeter and submillimeter wave range.** Feldman, Y. Phys Rev Lett. 2008 Mar 28;100(12):128102. <https://www.ncbi.nlm.nih.gov/pubmed/18517913>

20) **Modeling of reflectometric and ellipsometric spectra from the skin in the terahertz and submillimeter waves region.** Ney, M. J Biomed Opt. 2011 Jun;16(6):067006. <https://www.ncbi.nlm.nih.gov/pubmed/21721827>

21) **Twenty Four-Hour Exposure to a 0.12 THz Electromagnetic Field Does Not Affect the Genotoxicity, Morphological Changes, or Expression of Heat Shock Protein in HCE-T Cells.** Int J Environ Res Public Health. 2016 Aug 5;13(8) . Koyama , S. <https://www.ncbi.nlm.nih.gov/pubmed/27527204>

22) **Terahertz radiation at 0.380 THz and 2.520 THz does not lead to DNA damage in skin cells in vitro.** Radiat Res. 2013 Jan;179(1):38-45 <https://www.ncbi.nlm.nih.gov/pubmed/23181591>

23) **Verizon and AT&T Prepare to Bring 5G to Market.** Dec 30, 2016. <http://spectrum.ieee.org/telecom/wireless/verizon-and-att-prepare-to-bring-5g-to-market>

24) **IEEE.org- Spectrum News Articles.** <http://spectrum.ieee.org/Augmented-Reality:Forget-the-Glasses>. Dec 29, 2016. <http://spectrum.ieee.org/consumer-electronics/gaming/augmented-reality-forget-the-glasses>

25) **Facebooks Face Recognition Tech Goes on Trial.** <http://spectrum.ieee.org/biomedical/imaging/facebook-faces-face-recognition-tech-goes-on-trial>

26) **Electronic Frontier Foundation.** <https://www.eff.org/>

27) **Saying kids were endangered, Uganda is closing schools backed by U.S., World Bank, Bill Gates and Mark Zuckerberg Charter Schools-** https://www.washingtonpost.com/news/answer-sheet/wp/2016/08/17/saying-kids-were-endangered-uganda-is-closing-schools-backed-by-u-s-world-bank-bill-gates-and-mark-zuckerberg/?utm_term=.31419cad3801

28) **Reactions of biological systems of various complexity to the action of low-level EHF radiation.** Chernyakov GM, Korochkin VL, Babenko AP, Bigdai EV (1989). In Devyatkov ND (ed): "Millimeter Waves in Medicine and Biology". Moscow: Radioelectronica, pp 141-167 (in Russian).

- 29) **FCC Docket FCC 15-138. Jan 26, 2016** https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-138A1_Rcd.pdf
- 30) **5G Spectrum Frontiers filings to FCC- Docket- 14-177.** https://www.fcc.gov/ecfs/search/filings?limit=25&offset=75&proceedings_name=14-177&sort=date_disseminated,DESC
- 31) **FCC filing docket 13-39. June 4, 2013- Info on reevaluation of safety standards and wifi in schools.** Sage-<https://ecfsapi.fcc.gov/file/7520941649.pdf>
- 32) **FCC Filing Bioinitiative summary on reevaluation of standards-** <https://ecfsapi.fcc.gov/file/7520939954.pdf>
- 33) **National Academies of Science, Engineering and Medicine. Report on Potential Health Effect of Wireless Communication Devices.** <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12036>
- 34) **[Evaluation of genotoxic and/or co-genotoxic effects in cells exposed in vitro to extremely-low frequency electromagnetic fields].** Scassellati Sforzolini. Ann Ig. 2004 Jan-Apr;16(1-2):321-40G<https://www.ncbi.nlm.nih.gov/pubmed/15554538>
- 35) **Effects of co-exposure to extremely low frequency (50 Hz) magnetic fields and xenobiotics determined in vitro by the alkaline comet assay.** Villarini M. Sci Total Environ. 2006 May 15;361(1-3):208-19. Sci Total Environ. 2006 May 15;361(1-3):208-19.
- 36) **Extremely low frequency magnetic fields cause oxidative DNA damage in rats.** Yokus B. Int J Radiat Biol. 2008 Oct;84(10):789-95.<https://www.ncbi.nlm.nih.gov/pubmed/18979312>
- 37) **Induction of micronuclei and superoxide production in neuroblastoma and glioma cell lines exposed to weak 50 Hz magnetic fields.** Kesari KK. J R Soc Interface. 2016 Jan;13(114) . <https://www.ncbi.nlm.nih.gov/pubmed/26791000>
- 38) **Pre-exposure to 50 Hz magnetic fields modifies menadione-induced genotoxic effects in human SH-SY5Y neuroblastoma cells.** Luukkonen J. PLoS One. 2011 Mar 23;6(3).

- 39) **Animal studies on the role of 50/60-Hertz magnetic fields in carcinogenesis.** Löscher W. Life Sci. 1994;54(21):1531-43.
- 40) **Genomic instability induced by 50Hz magnetic fields is a dynamically evolving process not blocked by antioxidant treatment.** Kesari KK. Mutat Res Genet Toxicol Environ Mutagen. 2015 Dec;794:46-51. <https://www.ncbi.nlm.nih.gov/pubmed/26653983>
- 41) **Do electromagnetic fields enhance the effects of environmental carcinogens?** Juutilainen J. Radiat Prot Dosimetry. 2008;132(2):228-31. <https://www.ncbi.nlm.nih.gov/pubmed/18977776>
- 42) **FCC Filing 14-177. CITA-** <https://www.fcc.gov/ecfs/filing/1025161301514>
- 43) **FCC Filing 14-177- Satellite Industry Association.** <https://www.fcc.gov/ecfs/filing/1003878007495/document/10038780074954070>
- 44) **FCC Filing 14-177- WiFi Alliance.** <https://ecfsapi.fcc.gov/file/1093082983944/Wi-Fi%20Alliance%20Comments%20on%20Millimeter%20Wave%20FNPRM.pdf>
- 45) **FCC letter- T Mobile- October 1, 2016.** <https://www.fcc.gov/ecfs/filing/100105449239/document/100105449239a495>
- 46) **FCC Filing 14-177 Facebook. Oct 1, 2016.** <https://www.fcc.gov/ecfs/filing/10012127400524/document/1001212740052496aa>
- 47) **FCC Filing 14-177 5G Americas-** <https://www.fcc.gov/ecfs/filing/1093077796003/document/1093077796003462f>
- 48) **FCC Filing 14-177- Telecommunications Industry Association.** <https://www.fcc.gov/ecfs/filing/10930622009381/document/1093062200938116fe>
- 49) **UN Convention on the Rights of the Child. 1989.** <http://www.ohchr.org/en/professionalinterest/pages/crc.aspx>

50) **Western countries 1989-2010: Cause for concern.** Pritchard C. Surg Neurol Int. 2015 Jul 23;6:123. <https://www.ncbi.nlm.nih.gov/pubmed/?term=PMC4521226>

51) **European Manifesto in Support of European Citizens Initiative to Regulate EMF Exposure.** http://www.peccem.org/DocumentacionDescarga/Campanas/ICE2013/ENG_EUROPEAN_MANIFESTO_IN_SUPPORT_THE_ECI.pdf

52) **Letter to the Pope. The Church and the Urgent Protection of Life Against Electromagnetic Pollution.** July 2016. <http://www.peccem.org/DocumentacionDescarga/internacional/Letter.to.the.Pope.Francis.WYD.2016-EN.pdf>

53) **FCC Filing 14-177- Patricia Burke-Catholic-** <https://www.fcc.gov/ecfs/filing/1093087536094/document/1093087536094360d>

54) **FCC Filing 14-177 Lind Kurtz. Sept 29, 2016.** <https://www.fcc.gov/ecfs/filing/109292235821570>

55) **FCC Filing 14-177- Veronica Zrnchik.** Electrosensitive. <https://www.fcc.gov/ecfs/filing/10930262319207/document/109302623192073205>

56) **Mobile phones and vanishing birds-** <http://www.i-sis.org.uk/MPVB.php>

57) **Mobile Phones and Vanishing Bees-** <http://www.i-sis.org.uk/MobilePhonesVanishingBees.php>

58) **Bioeffects of microwave—a brief review.** S. Banik . Bioresource Technology 87 (2003) 155–159. https://www.researchgate.net/profile/Dr_Shymal_Banik/publication/10745209_Bioeffects_of_microwave_-_A_brief_review/links/543f95d80cf27832ae8b8e41.pdf

59) **FCC Guidelines for exposure to microwave EMF.** [tsiangaw@gmail.com https://www.gpo.gov/fdsys/pkg/CFR-2002-title47-vol1/pdf/CFR-2002-title47-vol1-sec1-1310.pdf](https://www.gpo.gov/fdsys/pkg/CFR-2002-title47-vol1/pdf/CFR-2002-title47-vol1-sec1-1310.pdf)

60) International Association of Firefighters. Division of Occupational Health Safety and Medicine. Position on Health Effects from Radiofrequency/Microwave radiation in Fire Department Facilities from Base Stations for Antennas and Towers for the Conduction of Cell Phone Transmissions. Adopted 2004. Firefighters stopped cell towers due to concerns of general health and neurologic symptoms. <http://www.iaff.org/hs/facts/CellTowerFinal.asp>

61) Annual Wireless Industry Survey. CTIA. 2015. <http://www.ctia.org/industry-data/ctia-annual-wireless-industry-survey>

62) FCC- 5G Remarks of Chairman Wheeler on “The Future of Wireless” June 20, 2016. <https://www.fcc.gov/document/remarks-chairman-wheeler-future-wireless>

63) NASA Report - Electromagnetic Field Interactions with the Human Body: Observed Effects and Theories. April 1981. Jeremy Raines, PhD. <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19810017132.pdf>

64) French companies will have to protect employees from electromagnetic waves. Jan 1, 2017. <https://www.legifrance.gouv.fr/eli/decret/2016/8/3/ETST1611714D/jo>
<https://www.franceinter.fr/societe/les-entreprises-vont-devoir-protoger-les-salaries-des-ondes-electromagnetiques>

65) Differential sensitivity of developmental stages to low-level electromagnetic radiation of extremely ultrahigh frequency. Belyaev IYa, Okladnova OV, Izmailov DM, Sheglov VS, Obukhova LK (1990). Dokl Akad Nauk SSSR [Ser B Geol Chim Biol] 12:68-70 (in Russian).

66) Why You May Have Good Reason to Worry About All those Smart Devices. Larry Downes. Washington Post. Dec 6, 2017. https://www.washingtonpost.com/news/innovations/wp/2016/12/06/why-you-may-have-good-reason-to-worry-about-all-those-smart-devices/?utm_term=.ba8722675d72

67) "What's the Diagnosis Doctor?" Dr. Scott Eberle. SCCMA Bulletin Nov 2016. <http://www.sccma-mcms.org/NewsEvents/BulletinMemberMagazine.aspx>

68) **Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder.** Belpomme, D. Rev Environ Health. 2015;30(4):25-71. <https://www.ncbi.nlm.nih.gov/pubmed/26613326>

69) **Effects of low-intensity electromagnetic radiation in the millimeter range on the cardio-vascular system of the white rat.** Potekhina IL, Akoyev GN, Yenin LD, Oleyner VD (1992): Fiziol Zh [formerly Fiziol Zh SSSR] 78: 35-41 (in Russian).

70) **The Body Electric: Electromagnetism and the Foundation of Life.** Dr. Robert Becker.1985. https://archive.org/stream/pdfy-uFS7t2QiFyjQBsU/The%20Body%20Electric_djvu.txt

71) **Current State and Implications of Research on Biological Effects of Millimeter Waves: A Review of the Literature.** Andrei G. Pakhomov. Bioelectromagnetics 19:393–413 (1998)
<http://www.rife.org/otherresearch/millimeterwaves.html>

72) **State of knowledge on biological effects at 40–60 GHz.** Yves Le Dréan, Yonis Soubere Mahamoud, Yann Le Page, Denis Habauzit, Catherine Le Quément, Maxim Zhadobov, Ronan Sauleau. State of knowledge on biological effects at 40–60 GHz. Comptes Rendus Physique, 14(5): 402-411.2013.<http://fulltext.study/preview/pdf/1860108.pdf>
<http://www.sciencedirect.com/science/article/pii/S1631070513000480>

73) **Transcriptome Analysis Reveals the Contribution of Thermal and the Specific Effects in Cellular Response to Millimeter Wave Exposure.** Oct.14, 2014. PlosOne.Habauzit,
D. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4193780/> or <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0109435>

74) **Experimental studies on the influence of millimeter radiation on light transmission through the lens.** Prost, M. Klin Oczna. 1994 Aug-Sep;96(8-9):257-9. <https://www.ncbi.nlm.nih.gov/pubmed/7897988>

- 75) **The Human Body and Millimeter-Wave Wireless Communication Systems: Interactions and Implications.** T.Wu, T. S. Rappaport, C. M. Collins. 2015 IEEE International Conference on Communications (ICC), Jun. 2015.
- 76) **[Microwaves and the visual analyzer].** Zuev VG. Aviakosm Ekolog Med. 1992 Jul-Aug;26(4):4-8. <https://www.ncbi.nlm.nih.gov/pubmed/1296837>
- 77) **[Early ultrastructural reactions in various parts of the visual analyzer in guinea pigs after thermogenic microwave irradiation].** Ryzhov AI. Arkh Anat Gistol Embriol. 1991 Jul-Aug;100(7-8):30-6. <https://www.ncbi.nlm.nih.gov/pubmed/1843431>
- 78) **Visually evoked hemodynamical response and assessment of neurovascular coupling in the optic nerve and retina.** Riva CE. Prog Retin Eye Res. 2005 Mar;24(2):183-215. <https://www.ncbi.nlm.nih.gov/pubmed/15610973>
- 79) **Dosimetric study of microwave cataractogenesis.** Foster MR. Bioelectromagnetics. 1986;7(2):129-40. <https://www.ncbi.nlm.nih.gov/pubmed/3741488>
- 80) **Report of electromagnetic radiation surveys of video display terminals.** NIOSH. Moss,C.E. 1977
<https://www.cdc.gov/niosh/nioshtic-2/00081009.html>
- 81) **Radiation Emissions and Their Effects.** Radiation Effects of Video Display Terminals. 1983. <https://www.ncbi.nlm.nih.gov/books/NBK216487/>
- 82) **Cataracts and avionic radiations.** Zaret,MM. Br J Ophthalmol. 1977 Jun;61(6):380-4. <https://www.ncbi.nlm.nih.gov/pubmed/871464>
- 82) **NASA study of cataract in astronauts (NASCA). Report 1: Cross-sectional study of the relationship of exposure to space radiation and risk of lens opacity.** Chylack LT. Radiat Res. 2009 Jul;172(1):10-20. <https://www.ncbi.nlm.nih.gov/pubmed/19580503>
- 83) **The impact of the new biology on radiation risks in space.** Dicello JF. Health Phys. 2003 Jul;85(1):94-102. <https://www.ncbi.nlm.nih.gov/pubmed/12861962>

84) **Electromagnetic Energy and Cataracts.** Dr. Milton Zaret. http://andrewamarino.com/PDFs/MB/MB_Ch24.pdf

85) **Industry Denies Health Threat : Explosion in Use of VDTs Spurs Regulation Debate.** LA Times. August 10, 1985. http://articles.latimes.com/1985-08-10/news/mn-3713_1_vdt-safety/4

86) **Safety of VDTs: Are They Really User-friendly?** Mary T. Schmich. July 21, 1985 http://articles.chicagotribune.com/1985-07-21/features/8502170510_1_vdt-workers-vdt-operators-tinker/2

87) **The strange case of Irving Selikoff.** Anthony Seaton. Occup Med (2010) 60 (1): 53.
<https://academic.oup.com/occmed/article/60/1/53/1439563/The-strange-case-of-Irving-Selikoff>

88) **Science is not sufficient: Irving J. Selikoff and the asbestos tragedy.** McCulloch J. New Solut. 2007;17(4):293-310. <https://www.ncbi.nlm.nih.gov/pubmed/18184623>

89) **Shooting the messenger: the vilification of Irving J. Selikoff.** McCulloch J. Int J Health Serv. 2007;37(4):619-34. <https://www.ncbi.nlm.nih.gov/pubmed/18072311>

90) **Crown Castle plan for DAS in Palo Alto.** http://www.crowncastle.com/projects/palo-alto_ca.aspx

91) **City of Palo Alto Architectural Review Board meeting minutes 10/15/15. Summary Title: Crown Castle Downtown Wireless Project.** <https://www.cityofpaloalto.org/civicax/filebank/documents/49415>

92) **Architectural Review Board for DAS At&T. City of Palo Alto. August 4, 2011.** <http://www.cityofpaloalto.org/civicax/filebank/documents/28220>

93) **Naval Medical Research Institute. 1971. Bibliography of Reported Biological Phenomena (“Effects”) and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation.** Report No. 2 Revised. Zorach Glaser, PhD, Lt. MSC, USN. April 20th 1972.
http://www.justproveit.net/sites/default/files/prove-it/files/military_radiowave.pdf

94) **Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression.** Pall, M. Journal of Chemical Neuroanatomy. Volume 75, Part B, September 2016, Pages 43–51

<http://www.sciencedirect.com/science/article/pii/S0891061815000599>
sedat

95) **UCSF Letter from John to Assistant to the President for Science and Technology regarding airport**

scanners. <http://www.npr.org/assets/news/2010/05/17/concern.pdf>

96) **The Internet Of Things Won't Be Big It'll Be**

Huge. <http://www.forbes.com/sites/markpmills/2016/09/28/the-internet-of-things-wont-be-big-itll-be-huge/#70718ffb3a1c>

97) **What is a smart**

city? <http://smartcities.gov.in/writereaddata/What%20is%20Smart%20City.pdf>

98) **5G Future:** <https://www.youtube.com/watch?v=6-XWCJggMAo>

99) **Everything You Should Know About 5G!**

https://www.youtube.com/watch?v=ikR0_ptc4P4

100) **So, what's 5G exactly? Samsung**

https://www.youtube.com/watch?v=_GMMtMKYH2A

101) **Qualcomm Snapdragon 835 Unveil | CES 2017**

<https://www.youtube.com/watch?v=QvnaBT79gn0>

102) **Millimeter Waves Will Expand the Wireless**

Future. <http://electronicdesign.com/communications/millimeter-waves-will-expand-wireless-future>

103) **How the microwave was invented by a radar engineer who accidentally cooked a candy bar in his pocket. July 3, 2015.**

<http://www.businessinsider.com/how-the-microwave-oven-was-invented-by-accident-2015-4>

104) **Chronic Disease Prevention and Health promotion.**

CDC. <https://www.cdc.gov/chronicdisease/>

105) MILKEN INSTITUTE STUDY: CHRONIC DISEASE COSTS U.S. ECONOMY MORE THAN \$1 TRILLION

ANNUALLY. <http://www.fightchronicdisease.org/latest-news/milken-institute-study-chronic-disease-costs-us-economy-more-1-trillion-annually>

106) Evolution and Earth's Electric

Field. <https://www.thunderbolts.info/wp/2015/10/08/evolution-and-earths-electric-field/>

107) A World Without Day or

Night. https://www.mpg.de/943613/S003_Flashback_060_061.pdf

108) The Origin and Evolution of Life. Tom Fenchel. Pg 23.

109) WHO 1981 Radiofrequency and Microwaves. Biologic Effects and Health Hazards of Microwave Radiation: Proceedings on International Symposium

1973. Warsaw, Oct 15-18, 1973. Sponsored by the WHO, US Department of Health, Education and Welfare, and The Scientific Council to the Minister of health and Social Welfare,

Poland. http://apps.who.int/iris/bitstream/10665/39107/1/9241540761_eng.pdf

110) Qualcomm's 5G preview: High frequencies, 5-gigabit

speed. <http://www.computerworld.com/article/3131842/mobile-wireless/qualcomms-5g-preview-high-frequencies-5-gigabit-speed.html>

111) How do Satellites communicate?

NASA. https://www.nasa.gov/directorates/heo/scan/communications/outreach/funfacts/txt_satellite_comm.html

112) Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. Hardell

L. Int J Oncol. 2013 Dec;43(6):1833-

45. <http://www.ncbi.nlm.nih.gov/pubmed/24064953>

113) Pooled analysis of case-control studies on acoustic neuroma diagnosed

1997-2003 and 2007-2009 and use of mobile and cordless phones. Hardell L. Int

J Oncol. 2013 Oct;43(4):1036-44. <http://www.ncbi.nlm.nih.gov/pubmed/23877578>

- 114) **Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries.** Cardis E. *Occup Environ Med.* 2011 Sep;68(9):631-40. <http://www.ncbi.nlm.nih.gov/pubmed/21659469>
- 115) **Mobile phone use and risk of tumors: a meta-analysis.** Myung SK, Moskowitz JM. *J Clin Oncol.* 2009 Nov 20;27(33):5565-72. <http://www.ncbi.nlm.nih.gov/pubmed/?term=cell+phones+brain+cancer+joel+moskowitz>
- 116) **Pooled analysis of two Swedish case-control studies on the use of mobile and cordless telephones and the risk of brain tumours diagnosed during 1997-2003.** Mild KH, Hardell L. *Int J Occup Saf Ergon.* 2007;13(1):63-71. <http://www.ncbi.nlm.nih.gov/pubmed/17362659>
- 117) **Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years.** Hardell L. *Occup Environ Med.* 2007 Sep;64(9):626-32. <http://www.ncbi.nlm.nih.gov/pubmed/17409179>
- 118) **Case-control study on cellular and cordless telephones and the risk for acoustic neuroma or meningioma in patients diagnosed 2000-2003.** Hardell L. *Neuroepidemiology.* 2005;25(3):120-8. <http://www.ncbi.nlm.nih.gov/pubmed/15956809>
- 119) **Biological effects of electromagnetic fields.** Adey, WR. *J Cell Biochem.* 1993 Apr;51(4):410-6. <https://www.ncbi.nlm.nih.gov/pubmed/8388394>
- 120) **Skin heating effects of millimeter-wave irradiation-Thermal modeling results.** Nelson, D. A., M. T. Nelson, T. J. Walters, and P. A. Mason. *IEEE Transactions on Microwave Theory and Techniques* 48:2111-2120, 2000. <http://ieeexplore.ieee.org/document/884202/>
- 121) **Heating and pain sensation produced in human skin by millimeter waves: comparison to a simple thermal model.** Walters, T. J., D. W. Blick, L. R. Johnson, E. R. Adair, and K. R. Foster. *Health Physics* 78:259- 267, 2000. <https://www.ncbi.nlm.nih.gov/pubmed/10688448>
- 122) **Comparison of blood pressure and thermal responses in rats exposed to millimeter wave energy or environmental heat.** Millenbaugh NJ. *Shock.* 2006 Jun;25(6):625-32. <https://www.ncbi.nlm.nih.gov/pubmed/16721271>

123) **Current State and Implications of Research on Biological Effects of Millimeter Waves: A Review of the Literature.** Andrei G. Pakhomov. Bioelectromagnetics 19:393–413 (1998). <http://www.rife.org/otherresearch/millimeterwaves.html>

124) **National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley SD Rats (Whole Body Exposure).** 2016. <http://dx.doi.org/10.1101/055699>.

125) **National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation.** May 2016. <https://ntp.niehs.nih.gov/results/areas/cellphones/>

126) **Major Cell Phone Radiation Study Reignites Cancer Questions. Scientific America.** May 2016. <https://www.scientificamerican.com/article/major-cell-phone-radiation-study-reignites-cancer-questions/>

127) **Ron Melnick PhD Commentary on the National Toxicology Program Radiofrequency and Cancer Study.** <http://ehtrust.org/ron-melnick-phd-commentary-national-toxicology-program-radiofrequency-cancer-study/>

128) **Radiofrequency radiation injures trees around mobile phone base stations.** Waldmann-Selsam C. Sci Total Environ. 2016 Dec 1;572:554-569 <https://www.ncbi.nlm.nih.gov/pubmed/27552133>.

130) **Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment.** Kues HA. Bioelectromagnetics. 1992;13(5):379-93 <https://www.ncbi.nlm.nih.gov/pubmed/1445419>

131) **[Suppression of nonspecific resistance of the body under the effect of extremely high frequency electromagnetic radiation of low intensity].** Kolomytseva MP. Biofizika. 2002 Jan-Feb;47(1):71-7. <https://www.ncbi.nlm.nih.gov/pubmed/11855293>

132) **Effects of low-intensity extremely high frequency electromagnetic radiation on chromatin structure of lymphoid cells in vivo and in vitro].** Gapeev AB. Radiats Biol Radioecol. 2003 Jan-Feb;43(1):87-92. <https://www.ncbi.nlm.nih.gov/pubmed/12677665>

133) Low power density microwave radiation induced early changes in rabbit lens epithelial cells. Ye, J. Chin Med J (Engl). 2001 Dec;114(12):1290-4. Chin Med J (Engl). 2001 Dec;114(12):1290-4. <https://www.ncbi.nlm.nih.gov/pubmed/11793856>

134) Effect of millimeter-band radiation of nonthermal intensity on the sensitivity of staphylococcus to various antibiotics. Bulgakova VG, Grushina VA, Orlova TI, Petrykina ZM, Polin AN, Noks PP, Kononenko AA, Rubin AB (1996). Biofizika 41:1289-1293 (in Russian). <https://www.ncbi.nlm.nih.gov/pubmed/9044624>

135) Adey, WR. 1993. **Biological Effects of Electromagnetic Fields.** Journal of Cellular Biochemistry 51:410-416.

136) **The Big Disconnect.** Catherine Steiner-Adair. Published 2013.

137) **The role of electromagnetic fields in neurological disorders.** Journal of Chemical Neuroanatomy. Terzi, M, Ozberk, B, Deniz, OG, Kaplan, S. Available online 12 April 2016. <http://1.usa.gov/1SVOa2g>

138) **Gray matter abnormalities in Internet addiction: a voxel-based morphometry study.** Zhou, Y. Eur J Radiol. 2011 Jul;79(1):92-5. <https://www.ncbi.nlm.nih.gov/pubmed/19926237>

139) **BioInitiative Working Group,** Cindy Sage and David O. Carpenter, Editors. BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Radiation at www.bioinitiative.org, December 31, 2012 at www.bioinitiative.org