



Published on SEJ (<https://www.sej.org>)

Is Wireless Technology an Environmental Health Risk? ^[1]

January 6, 2021

By Katie Alvord



Increasing exposures to non-ionizing electromagnetic radiation, including the radiofrequency radiation, is at the center of a long-standing dispute over the dangers to human health and the environment. Photo [4]: Alistair McIntyre, Pixabay. [3]

Early in 2012, I started having debilitating cognitive lapses, pressure headaches, nausea and worse when around wireless and electronic devices.

That winter and spring, I'd put in long hours, drafting an eco-themed novel, writing for a hyperlocal news blog and starting to update a climate series I'd done for the site five years before.

But my worsening symptoms felt more extreme than simply too-much-screen-time fatigue. By late May, I could not sit down at any keyboard without losing my ability to work within minutes.

"What changed before this began?" one doctor asked me. As we explored the question, technology kept coming up.

Not only had I logged extra computer time in recent months, but a new community-wide wireless internet service had started nearby. My symptoms consistently worsened within what I later learned was the range of that service. The 12-mile trips from my country home into town, where this new provider and others had transmitters, often left me so impaired it took days to recover.

Was it possible higher levels of wireless radiation had crashed my health?

My search for answers led me deep into a topic that has expanding relevance for the environmental beat in the current COVID-19 era.

Recent lockdowns and more time online — plus the push for rapid expansion of 5G infrastructure, now touted for economic recovery (see sidebar) — are increasing our exposures to non-ionizing electromagnetic radiation (EMR, aka electromagnetic fields or EMF). This includes the radiofrequency radiation, or RFR, emitted by wireless devices.

Are these exposures safe? That's hotly debated, so you'll find plenty of story potential at the intersection of wireless tech, health and environment.

Plus, Project Censored [5] — which since 1976 has publicized important news stories missed by mainstream media — says [5] the health risks of wireless technologies are underreported. The topic has made the group's annual list of Top 25 Censored Stories in 2012-13 [6], 2017-18 [7] and 2018-19 [8].

The safety debate

Arguments over these health risks center on whether RFR, which includes microwave frequencies, does much or any harm when below intensities that heat tissue.

Those who say that low-intensity RFR poses little risk include the U.S. Federal Communications Commission [9], or FCC, the U.S. Food and Drug Administration [10], or FDA, the Institute of Electrical and Electronics Engineers [11], the International Commission on Non-Ionizing Radiation Protection [12] and the wireless industry [13].

Accordingly, safety standards and guidelines in the United States and many other locations are based on avoiding RFR's tissue-heating effects.

Those concerned about this approach say thousands of studies — such as research cited by the BioInitiative Report [14], Physicians for Safe Technology [15], Americans for Responsible Technology [16], Understanding EMFs [17], Electromagnetic Radiation Safety [18] and Environmental Health Trust [19] — conclude that RFR can hurt us at levels well below those microwave ovens used for cooking.

[DISCLOSURE: In October 2019, the author became one of four directors of a small family foundation whose donations include some to charities which research and/or educate the public about wireless radiation health risks, among them: Environmental Health Trust, the Golomb Research Group at University of California-San Diego and others not mentioned in this story.]

The non-thermal biological effects linked to RFR by these studies include increased cancer risk [20], DNA damage [21], sperm degradation [22] and more.

The International EMF Scientist Appeal says these effects can occur at intensities of RFR considered safe by “most international and national guidelines.” The appeal, now signed by more than 250 scientists from more than 40 countries, asks the United Nations, its sub-organizations including the World Health Organization, or WHO, and its member nations for greater public health protection from EMF exposure.

Echoing those concerns, a 2018 Lancet Planetary Health [23] article reported that, of 2,266 studies evaluated, 1,546 “demonstrated significant biological or health effects associated with exposure” — both acute and chronic — to anthropogenic EMR, including RFR.

In contrast, the wireless industry says “the overall balance” of RFR science shows little risk, as Mark Hertsgaard and Mark Dowie wrote in 2018 [24] in *The Nation*. Their article also reported that when industry-funded research is excluded, larger proportions of studies show low-intensity RFR can cause harm.

Hertsgaard and Dowie described an analysis by Henry Lai, a bioengineering professor emeritus at the University of Washington who showed that while 67 percent of independently-funded studies found biological effects from cellphone radiation, just 28 percent of industry-funded studies did the same. A 2007 analysis [25] in *Environmental Health Perspectives* replicated Lai’s findings.

This sort of published science has had limited influence on public policy, especially since passage of the Telecommunications Act of 1996. This law bars states and localities from regulating wireless facilities based on RFR-related environmental concerns. Subsequent legal rulings determined that this includes concerns about RFR’s health risks.

Thus, no wireless infrastructure policies can be based on RFR research showing non-thermal health effects except at the federal level, mainly through the FCC.

Against this backdrop — and sometimes obscured by special-interest spin or tales of conspiracy — several issues are playing out, offering multiple angles for stories.

Cancer: Can wireless radiation increase the risk?

There’s “clear evidence” for rare cancers called schwannomas of the heart, concludes a 2018 paper by the U.S. National Toxicology Program, or NTP [26], and “some evidence” it’s a yes for malignant gliomas of the brain.

Although aspects of the NTP’s rodent study have been debated by scientists and regulators [27], Italy’s Ramazzini [28] Institute has corroborated the NTP findings. Both long-term studies show “an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats,” the Ramazzini study says.

Despite the NTP findings, the FDA — which initially called for the study — responded with a statement affirming [29] the acceptability of current cell phone safety standards. Uncertainty remains about possible responses from other agencies now planning to review RFR's carcinogenicity, including the WHO's International Agency for Research on Cancer, or IARC.

As early as 2011, enough research had linked RFR to cancer so that IARC listed it as “possibly carcinogenic [30] to humans.” Other agencies and scientific organizations have issued similar cautions [31]. Now, some scientists want IARC to step up its RFR designation [32] to “probable carcinogen” or definite “carcinogen.” IARC has prioritized this issue for consideration in the near future.

Meantime, wireless cancer risk studies continue to accumulate. One example is a meta-analysis [33] published November 2, 2020 in the International Journal of Environmental Research and Public Health. This study found that “cell phone use with cumulative call time more than 1,000 hours significantly increased the risk of tumors.” It noted that 1,000 hours corresponds to roughly 17 minutes a day for 10 years.

Regulators — including the FCC — continue to argue that existing wireless safety guidelines are adequate. But the issue is going before federal judges. Pending in court are lawsuits claiming people's tumors [34] came from cell phone use, as well as lawsuits challenging FCC safety regulations [35].

On another regulatory front, should consumers have the “right to know” of possible wireless cancer risks — for instance, via point-of-sale notices as mandated until recently in Berkeley [36], California? The city's test-case ordinance required retailers to post warnings recommending that customers heed safety instructions required in phone manuals by the FCC but rarely read. These include the typically half-inch distance users should keep cell phones away from the body to meet exposure guidelines (keeping live phones in bras or pockets, for instance, does not generally do so).

Though the wireless industry sued Berkeley shortly after the 2015 passage of its ordinance, early rulings sided with the city, and included industry losses [37] (subscription required) in the U.S. Supreme Court. But as Bob Egelko reported [38] (subscription required) in the San Francisco Chronicle, a June 2020 court filing by the FCC led a federal district judge to rule in September that Berkeley's ordinance interfered with federal oversight of the cellphone industry.

The city will leave its law unenforced for now. According to Egelko, an attorney representing Berkeley said the ordinance “remains on the books awaiting a better FCC.” This story might resurface early this year.

What about other health effects?

Numerous studies link low-intensity RFR exposures with various biological impacts, including heart [39] and circulatory problems, neurological [40] disorders, immune system [41] changes, reduced fertility [22], blood-brain barrier leakage [42], sleep [43] disruption, memory [44] impairment and more [45].

A 2015 review article [46] in Electromagnetic Biology and Medicine explored one explanation for this variety of potential effects: the “significant activation” by low-intensity RFR of “key pathways generating

reactive oxygen species” — in other words, generation of free radicals which can build up in biological tissues to create oxidative stress and related effects such as DNA damage.

Effects of this type were documented in 93 of the 100 human tissue, animal and plant studies that the article examined. The researchers write that this could explain “a range of biological/health effects of low-intensity RFR” and give this type of environmental exposure “a wide pathogenic potential.”

Children [47] and pregnant women [48] might be particularly vulnerable to such effects. Imaging in human head models like that done in a 2018 study [49] published in *Environmental Research* has shown that children’s thinner skulls allow more RFR penetration of their brains. This has raised concerns about WiFi in schools [50], as well as the additional screen time [51] required by pandemic-era digital schooling.



Imaging studies show children's thinner skulls allow more RFR penetration of their brains, raising concerns about WiFi in schools and added screen time during remote digital schooling. Photo: Tatiana Syrikova. [52].

What happened to me in 2012 is called electromagnetic hypersensitivity, or EHS [53], which is also known as electrosensitivity. It is considered an “idiopathic environmental illness” by the WHO and is not included as a separate condition in that agency’s International Classification of Diseases.

A recent edition of *Physician’s Weekly* calls EHS [54] a “clinical syndrome characterized by ... a wide spectrum of non-specific multiple organ symptoms.” Headaches, fatigue, insomnia and cognitive impairments are most common but a variety of other symptoms from heart arrhythmias to nausea to tinnitus are also reported, and can range from mild to disabling.

Although some have suggested EHS is psychogenic, research is accumulating [55] that concludes that it is not. Dr. Beatrice Golomb [56], who studies the condition, has stated [57] that “[EHS] symptoms arise from physiological injury.” [*Editor’s Note: See disclosure above.*]

A 2020 paper [58] by Dominique Belpomme and Philippe Irigaray lists EHS biomarkers — including oxidative stress by-products in blood samples and scan-detected blood-flow changes in the brain — and asks that EHS now be included as a separate condition in the WHO’s International Classification of Diseases.

Surveys of countries from Finland to Taiwan have estimated that EHS affects from 0.7% to 13.3% of studied populations. Noting an upward trend, a 2006 letter to *Electromagnetic Biology and Medicine* by scientists Örjan Hallberg and Gerd Oberfeld asked, “Will we all become electrosensitive [59]?” Already, write Belpomme and Irigaray, “millions of people may in fact be affected by EHS worldwide.”

How might wireless radiation affect nature?

Researchers have reported that birds [60] and bees [61] lose their navigational ability near cell towers, while trees [62] sport damaged leaves [63] and foliage die-off [64]. Studies also suggest that RFR might contribute to bird population declines, bee colony collapse disorder and recent dramatic drops in insect numbers.

A 2013 review [67] of 113 plant and animal studies catalogs these and other findings on RFR's impacts. So does Dr. Cindy Russell of Physicians for Safe Technology in her article, "Wireless Silent Spring [68]," which draws parallels between toxic chemicals and EMR.

Such impacts concerned the U.S. Department of the Interior [69] in 2014, when it wrote to the FCC that wireless safety guidelines did not adequately protect wildlife. But now, within Interior, the National Park Service is expanding wireless facilities, writes Christopher Ketcham [70] — including in the Grand Tetons, as reported by Jimmy Tobias [71] (who conducted his investigation with funding from the Society of Environmental Journalists [72]' Fund for Environmental Journalism).



Figure 1 Wireless cancer risk studies continue to accumulate, according to the author. Photo [66]: Alex Lamb, Flickr Creative Commons. [65].

These articles hint at openings for more media coverage of wireless tech's effects on nature. Study findings, too, raise opportunities for more reporting. Just how serious are the effects of RFR on flora and fauna? How might they impact various species in combination with factors such as habitat loss, chemical pollution or climate change?

More reporting issues and angles

- Wireless from space: Recent and proposed satellite launches will vastly expand wireless services from space. Astronomers [73] complain these satellites obscure the night sky; others [74] warn of potential health effects. What might be the cumulative impact of 50,000-plus wireless-from-space satellites and their transmitting/receiving equipment on Earth?
- 5G and forecasts: 5G has raised concerns beyond health — security, privacy and the integrity of weather forecasting among them. Columbia Journalism Review recently covered meteorologists' [75] worries. As 5G develops, will it impair collection of accurate water vapor data, as they fear, and compromise weather and climate forecasts?
- Misleading media: Journalists can do a better job drilling down to the facts on wireless radiation. Misleading media reports are all over the map. Recent stories with headlines like "5G networks [76] have few health impacts, study finds," covered research [77] that examined one 5G wavelength but did not include mm waves. Conversely, conspiracy theory stories alleging 5G horrors are overshadowing "real 5G issues," according to Investigate Europe [78], a nonprofit cross-border team of European journalists based in Germany.
- Our technological footprint: The internet's energy and ecological footprint is already large. How much bigger might the demand for mobile wireless connectivity make energy consumption, greenhouse gas emissions and other impacts on planetary health?
- Wary insurers: The insurance [79] industry was early among businesses to recognize climate change risks. Is its approach to wireless tech similar? Insurance policies class EMF as a "pollutant" and don't offer product liability coverage for devices. A related paper by Michigan Technological University Professor Joshua Pearce [80] recognizes potential wireless liability risks, advising that cell towers be sited away from schools and hospitals due to growing evidence of health effects.

- Environmental justice: Some science suggests [81] EMR and toxic chemicals, including metals, can have synergistic health impacts. Since higher toxic exposures often occur in low-income areas, tribal communities and communities of color, does placing wireless transmitters in those locations — especially if used in place of fiber to close the digital divide — constitute an environmental justice issue?
- Smart meters: “Smart” utility meters, which often transmit data using RFR, continue to elicit health complaints. Are you covering any? A 2011 SEJ TipSheet [82] written by the late environmental journalist Robert Weinhold provides relevant background.
- Medical EMR assessments: The non-specific symptoms sometimes attributed to EMR exposures — such as headache or fatigue — led the American Academy of Environmental Medicine [83] to suggest in 2012 that doctors routinely ask patients about their electromagnetic environments. How many doctors do so? How much might they overlook this or other environmental factors that could contribute to illness?
- Safer tech R&D: Is there potential for safer tech? Is your nearest university engineering department doing any feature-worthy research along these lines? In the last section of his article, “Wireless Wake-Up Call: A New Paradigm in EMF Science, [84]” engineer Jeromy Johnson covers areas of safer tech research and development — possible starting points for interview questions or background research.
- Home improvements: If we don’t use wireless, what then? Stories about creating lower-RFR homes [85] with cabled and corded alternatives might find a bigger audience among the pandemic period’s homebound populace.

By the way, journalist Louis Slesin [86] of Microwave News [87] is an ongoing source of story ideas and insights into EMR science and policy. Another useful source is Joel Moskowitz [88], director of U.C. Berkeley’s Center for Family and Community Health, whose Electromagnetic Radiation Safety [18] blog regularly posts summaries of and links to recent studies on EMR and health.

Some final words

I’m still electrosensitized, although not nearly as debilitated as in the first years after my health crashed. Avoiding RFR, I’ve found, has been the most effective way to avoid symptoms and maintain my health (see sidebar for how you can reduce your own potential risks). I don’t own a cell phone or anything wireless, and no longer use computers, at least not directly (helpful others typed up this story).

In the documentary Full Signal [89], Swedish EMR scientist Olle Johansson said that those of us with EHS might be “the lucky ones:” to avoid difficult symptoms, we often radically reduce our EMR exposure, thus cutting our potential risk of future — perhaps worse — health consequences.

Long-time SEJ member Katie Alvord is an award-winning freelance writer whose work has appeared in a range of publications. She received the 2007 AAAS Science Journalism Award for Excellence in Online Reporting, for writing a series on Lake Superior Basin climate change [90]. She has also worked with and written for libraries, government agencies and nonprofit groups, and is the author of “Divorce Your Car! [91]” Marjorie Alvord, Katie’s sister, contributed research, computerization and editorial material for this story.

5G — Environmental Health Threat, Economic Boon or Both?

By Katie Alvord

The rollout of 5th generation wireless technology, aka 5G, has begun amidst more debate over safety [92], wrote Christopher Ketcham in The New Republic in 2020.

Those promoting 5G argue for its economic benefits and say there's no reason to assume it's unsafe. Opponents counter we shouldn't presume 5G's safety [93] and we could have reasons for concern.

5G employs previously lesser-used frequencies called millimeter, or mm, waves, which don't travel far or easily penetrate walls or trees. The new technology's transmitters are generally closely spaced, every few hundred feet at the curb outside homes and businesses.

5G will be added to and integrated with 3G and 4G systems instead of replacing them. The planned addition of 5G's [94] close-range antennas alongside existing wireless infrastructure is raising fears that RFR exposure [95] will increase significantly due to more densely packed antennas.

Research indicates [96] mm waves penetrate only top layers of skin, but affect sweat glands more than other tissues. They might have systemic effects via circulatory or nervous system connections from skin to other organs. So far, prolonged exposures to low-intensity mm waves have not been extensively studied.

Physicians and scientists from over 40 countries — concerned over sparse 5G research, coupled with studies showing RFR harm — are calling for a 5G moratorium [97]. At the same time, many business and agency statements about 5G suggest that it's safe enough to deploy without further study.

When U.S. Sen. Richard Blumenthal (D-Conn.) asked [98] wireless industry and FCC representatives whether independent research had been done on 5G's impacts on health and environment, they responded that as far as they knew no safety testing [99] had been done.

As agencies and industry advance 5G and promote its economic benefits [100] (may require subscription), some groups have pushed back. In 2018, 19 tribal governments, the National Association of Tribal Historic Preservation Officers, the National Trust for Historic Preservation and the Natural Resources Defense Council sued the FCC after it issued an order to eliminate federal environmental impact review requirements for 5G [101].

In 2020, the complainants won [102] their case and reaffirmed that 5G facilities can't be built without National Environmental Protection Act compliance.

This win might help the more than 130 mostly-local U.S. groups [103] and communities that have been fighting 5G. Some locations — like Los Altos Hills, California, Easton, Connecticut and Hawaii County

[104], Hawaii — have taken steps to limit 5G expansion. The city of Boston [105] recently asked that the FCC review possible 5G health impacts to ensure safety of these technologies.

In 2019, New Hampshire [106] formed a commission to review 5G safety. After expanding its scope to all wireless tech over a year of study, the commission released its report on November 1, 2020. Among 15 recommendations endorsed by 10 of 13 commission members are:

- Require appropriate state agencies to disseminate wireless health and safety information.
- Place warning signs near 5G antennas in public rights-of-way.
- Shift schools and libraries from WiFi to hard-wired connections within five years of getting funding.
- Ask the FCC for an environmental impact statement on “the effect on New Hampshire and the country as a whole from the expansion of RF wireless technologies.”

Will state officials adopt these recommendations? Will other states follow New Hampshire’s lead? A report on wireless tech health effects, particularly in schools, is expected from the Oregon Health Authority early this year, and Massachusetts has been considering formation of both a 5G task force and a wireless safety commission. Outcomes of these policy actions bear watching.

How To Reduce Your Own Potential Risks

By Katie Alvord

Journalists often are exposed to wireless radiation as they work. There are ways experts suggest to take precautions around wireless without changing careers:

- Use cabled computers and corded landlines for as much work as possible.
- If you have wireless connections at home, turn them off when not in use, especially during sleep hours. One option: Put your router on a timer to switch it off at night.
- Keep wireless devices out of your bedroom while sleeping.
- Don’t use or carry operating wireless devices next to your body. Laptops shouldn’t go directly on your lap. Keep cellphones in packs or purses, not in shirt, pant or skirt pockets or bras.
- When on a cellphone, use the speaker function to keep the phone away from your head. Texting instead of calling also reduces RFR exposure.
- Put cell phones in “airplane” mode when using non-communication functions such as an alarm clock or cameras.
- When reviewing lengthy electronic documents, download first, then read offline with WiFi off.
- Consider opting out of smart utility meters and retaining analog meters, especially if meters are close to your bedroom or workspace.

For a more thorough set of science-based recommendations, I recommend “Minimizing EMF Risk,” Chapter 12 in the book “Overpowered: What Science Tells Us About the Dangers of Cell Phones and Other WiFi-Age Devices [107],” by Martin Blank, PhD.

If you, as I do, feel symptoms when exposed to RFR, be as thorough as possible at eliminating exposures and further risk.

Sources

- [1] This article on the SEJ website. <https://www.sej.org/publications/features/wireless-technology-environmental-health-risk>
- [2] SEJournal Online Features section. <https://www.sej.org/publications/features>
- [3] Cell tower photo (full size). <https://www.sej.org/sites/default/files/CellTower.jpg>
- [4] Cell tower photo source, Pixabay. <https://pixabay.com/photos/cell-tower-mobile-mast-2252153/>
- [5] Project Censored (home page). <https://www.projectcensored.org>
- [6] Project Censored, Top 25 of 2012–13: wireless technology and health. <https://www.projectcensored.org/14-wireless-technology-looming-health-crisis/>
- [7] Project Censored, Top 25 of 2017–18: how the wireless industry shaped safety perceptions. <https://www.projectcensored.org/4-how-big-wireless-convinced-us-cell-phones-and-wi-fi-are-safe/>
- [8] Project Censored, Top 25 of 2018–19: 5G health concerns. <https://www.projectcensored.org/12-new-5g-network-spurs-health-concerns/>
- [9] FCC consumer guide: wireless devices and health concerns. <https://www.fcc.gov/consumers/guides/wireless-devices-and-health-concerns>
- [10] FDA: scientific evidence for cell phone safety. <https://www.fda.gov/radiation-emitting-products/cell-phones/scientific-evidence-cell-phone-safety>
- [11] Institute of Electrical and Electronics Engineers (IEEE). <https://www.ieee.org/>
- [12] International Commission on Non-Ionizing Radiation Protection (ICNIRP). <https://www.icnirp.org/>
- [13] CTIA (wireless industry association). <https://www.ctia.org/>
- [14] BioInitiative Report. <http://www.bioinitiative.org>
- [15] Physicians for Safe Technology. <https://mdsafetech.org>
- [16] Americans for Responsible Technology: scientific studies. <https://www.americansforresponsibletech.org/scientific-studies>
- [17] Understanding EMFs. <https://sites.google.com/site/understandingemfs/contact>
- [18] Electromagnetic Radiation Safety (Joel Moskowitz). <https://www.saferemr.com/>
- [19] Environmental Health Trust. <https://ehtrust.org/>
- [20] Cancer risk study, Environmental Research (2018). <https://www.sciencedirect.com/science/article/pii/S0013935118303475>
- [21] DNA damage study, Environmental and Molecular Mutagenesis. <https://onlinelibrary.wiley.com/doi/epdf/10.1002/em.22343>
- [22] Sperm/fertility review, Reproduction. <https://rep.bioscientifica.com/view/journals/rep/152/6/R263.xml>
- [23] Lancet Planetary Health article on anthropogenic EMR (2018). [https://doi.org/10.1016/S2542-5196\(18\)30221-3](https://doi.org/10.1016/S2542-5196(18)30221-3)
- [24] Hertsgaard & Dowie, The Nation (2018): how the wireless industry shaped safety perceptions. <https://www.thenation.com/article/archive/how-big-wireless-made-us-think-that-cell-phones-are-safe-a-special-investigation/>
- [25] Funding-source analysis, Environmental Health Perspectives (2007). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1797826/>

- [26] National Toxicology Program cell phone RFR studies (fact sheet). https://www.niehs.nih.gov/health/materials/cell_phone_radiofrequency_radiation_studies_508.pdf
- [27] Debate over the NTP study, Environmental Research. <https://www.sciencedirect.com/science/article/abs/pii/S0013935118304973>
- [28] Ramazzini Institute rat study (PubMed). <https://pubmed.ncbi.nlm.nih.gov/29530389/>
- [29] FDA statement (Jeffrey Shuren) responding to the NTP findings. <https://www.fda.gov/news-events/press-announcements/statement-jeffrey-shuren-md-jd-director-fdas-center-devices-and-radiological-health-recent-national>
- [30] IARC 2011 classification of RF fields as possibly carcinogenic (document). <https://documentcloud.adobe.com/link/track?uri=urn:aaid:scds:US:5ae8f821-779c-4757-b52f-1ea98b5093fd#pageNum=1>
- [31] Environmental Health Trust: medical and scientific consensus statements. <https://ehtrust.org/science/medical-doctors-consensus-statements-recommendations-cell-phoneswireless/>
- [32] Paper arguing for a stronger IARC designation, Environmental Research. <https://www.sciencedirect.com/science/article/pii/S0013935118303475?via%253Dihub>
- [33] Meta-analysis of cell phone use and tumor risk, IJERPH (Nov. 2020). <https://www.mdpi.com/1660-4601/17/21/8079>
- [34] Environmental Health Trust: cell phone radiation litigation. <https://ehtrust.org/key-issues/cell-phone-radiation-litigation/>
- [35] Environmental Health Trust: brief filed in case against FCC regulations. <https://ehtrust.org/brief-filed-in-landmark-case-against-fcc-on-5g-and-wireless-regulations/>
- [36] Berkeleyside (2015): Berkeley passes cell phone right-to-know law. <https://www.berkeleyside.com/2015/05/13/berkeley-passes-cellphone-right-to-know-law>
- [37] San Francisco Chronicle: Berkeley warning survives (subscription). <https://www.sfchronicle.com/bayarea/article/Berkeley-s-cell-phone-health-warning-survives-14893869.php>
- [38] San Francisco Chronicle, Bob Egelko: Berkeley settles with wireless industry (subscription). <https://www.sfchronicle.com/bayarea/article/Berkeley-settles-with-wireless-industry-will-not-15628995.php>
- [39] Heart/cardiovascular study, European Journal of Preventive Cardiology. <https://journals.sagepub.com/doi/10.1177/2047487317734898>
- [40] Neurological effects study, Environmental Health Perspectives (PDF). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241519/pdf/ehp0111-000881.pdf>
- [41] Immune system effects (saferemr.com summary). <http://bit.ly/saferemrImmuneSystem>
- [42] Blood-brain barrier study, Environmental Health Perspectives. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241519/>
- [43] Sleep disruption study (PubMed). <https://pubmed.ncbi.nlm.nih.gov/23482083/>
- [44] Memory impairment study (PMC). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2666459/>
- [45] Review of health effects, Frontiers in Public Health (2019). <https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223/full>
- [46] Oxidative stress review, Electromagnetic Biology and Medicine (2015). <https://pubmed.ncbi.nlm.nih.gov/26151230/>
- [47] Children's RF exposure vs. adults, IEEE. https://ieeexplore.ieee.org/document/7131429?arnumber=7131429&queryText=Yes%2520the%2520children%2520are%2520more%2520exposed%2520to%2520radio-frequency%2520energy%2520from%2520mobile%2520telephones%2520than%2520adults&newsearch=true&searchField=Search_All
- [48] Joint statement on pregnancy and wireless radiation (saferemr.com). <https://www.saferemr.com/2014/06/joint-statement-on-pregnancy-and.html>
- [49] Head-model imaging study, Environmental Research (2018). <https://www.sciencedirect.com/science/article/abs/pii/S0013935118302561>
- [50] Wi-Fi in schools and public places (saferemr.com). <https://www.saferemr.com/2017/02/wi-fi-in-schools-other-public-places.html>
- [51] HealthyChildren.org: screen time guidance. <https://www.healthychildren.org/English/family-life/Media/Pages/Where-We-Stand-TV-Viewing-Time.aspx>

- [52] Photo of child with laptop (full size). <https://www.sej.org/sites/default/files/TatianaPhoto.jpg>
- [53] Santa Clara County Medical Association: EHS diagnosis article (PDF). <http://www.sccma.org/Portals/19/Whats%20the%20Diagnosis%20Doctor.pdf?ver=2016-12-09-152046-290>
- [54] Physician's Weekly: EHS / microwave syndrome review. <https://www.physiciansweekly.com/electromagnetic-hypersensitivity-ehs-microwave-syndrome-review-of-mechanisms/>
- [55] Research on electromagnetic hypersensitivity (saferemr.com). https://www.saferemr.com/2014/10/electromagnetic-hypersensitivity_30.html
- [56] Dr. Beatrice Golomb, CV (Golomb Research Group). <https://www.golombresearchgroup.org/pagecv>
- [57] Golomb letter opposing California SB 649. <http://www.ca4safertech.com/letter-uc-san-diego-school-medicine-professor-opposing-sb-649/>
- [58] Belpomme & Irigaray (2020): EHS biomarkers. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7139347/>
- [59] Hallberg & Oberfeld (2006): EHS prevalence letter (PDF). http://www.next-up.org/pdf/EHS2006_HallbergOberfeld.pdf
- [60] Manville briefing memo on birds and radiation, filed with FCC (2016). <https://ecfsapi.fcc.gov/file/12270470130362/Manville%207-14-%202016%20Radiation%20Briefing%20Memo-Public.pdf>
- [61] Environmental Health Trust: bees, butterflies and wildlife research. <https://ehtrust.org/science/bees-butterflies-wildlife-research-electromagnetic-fields-environment/>
- [62] Tree damage study (PubMed). <https://pubmed.ncbi.nlm.nih.gov/27552133/>
- [63] Leaf damage study, International Journal of Forestry Research (2010). <https://www.hindawi.com/journals/ijfr/2010/836278/>
- [64] Kompetenzinitiative tree observation guide (2017, PDF). https://kompetenzinitiative.com/wp-content/uploads/2019/08/2017_Observation_Guide_ENG_FINAL_RED.pdf
- [65] Wi-Fi photo (full size). <https://www.sej.org/sites/default/files/Wifi.jpg>
- [66] Wi-Fi photo source, Flickr. <https://www.flickr.com/photos/alexandralamb/21242133290/>
- [67] Review of 113 plant and animal studies (2013, PubMed). <https://pubmed.ncbi.nlm.nih.gov/23261519/>
- [68] Cindy Russell, "Wireless Silent Spring" (Physicians for Safe Technology). <https://mdsafetech.org/2018/11/03/wireless-silent-spring/>
- [69] U.S. Department of the Interior letter to FCC (2014). <https://documentcloud.adobe.com/link/track?uri=urn:aaid:scds:US:8fff6b22-37a8-4613-a364-aa77f21e7a10#pageNum=1>
- [70] Christopher Ketcham, Sierra (2020): Wi-Fi in wilderness. <https://www.sierraclub.org/sierra/2020-4-july-august/feature/wi-fi-wilderness>
- [71] Jimmy Tobias, High Country News: Park Service and telecom. <https://www.hcn.org/issues/52.3S/special-technology-the-park-service-is-selling-out-to-telecom-giants>
- [72] SEJ Fund for Environmental Journalism grantees, winter 2019. <https://www.sej.org/fej-grantees-winter-2019>
- [73] Science News: satellites and astronomy. <https://www.sciencenews.org/article/starlink-spacex-satellites-amazon-oneweb-global-internet-astronomy>
- [74] 5G Space Appeal. <https://www.5gspaceappeal.org/the-appeal>
- [75] Columbia Journalism Review: 5G and weather forecasting. https://www.cjr.org/special_report/under_the_weather.php
- [76] EurekAlert press release on a 5G health study (2020). https://eurekalert.org/pub_releases/2020-07/osu-5nh070820.php
- [77] Underlying 5G study, PLOS ONE (2020). <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0235869>
- [78] Investigate Europe: 5G and COVID conspiracy theories. <https://www.investigate-europe.eu/en/2020/5g-covid-conspiracy/>
- [79] Environmental Health Trust: insurance industry reports. <https://ehtrust.org/key-issues/reports-white-papers-insurance-industry/>
- [80] Joshua Pearce: cell tower siting and liability (Academia.edu). https://www.academia.edu/41138898/Limiting_Liability_with_Positioning_to_Minimize_Negative_Health_Effects_of_Cellular_Phone_Towers

- [81] EMR and chemical synergy study, ScienceDirect. <http://www.sciencedirect.com/science/article/pii/S0040162512003216>
- [82] SEJ TipSheet (2011), Robert Weinhold: smart meter health claims. <https://www.sej.org/publications/tipsheet/many-are-claiming-health-problems-caused-smart-meters>
- [83] American Academy of Environmental Medicine. <https://www.aemonline.org/>
- [84] Jeromy Johnson, "Wireless Wake-Up Call" (PDF). <https://www.tbp.org/pubs/Features/Su16Johnson.pdf>
- [85] Lower-RFR homes study, Building and Environment. <https://www.sciencedirect.com/science/article/pii/S0360132319305347>
- [86] SEJournal piece on journalist Louis Slesin. <https://www.sej.org/publications/sejournal/proof-is-in-information-be-reliable-accurate-fair>
- [87] Microwave News. <https://www.microwavenews.com/>
- [88] Joel Moskowitz, UC Berkeley School of Public Health. <https://publichealth.berkeley.edu/people/joel-moskowitz/>
- [89] Full Signal (documentary), IMDb. <https://www.imdb.com/title/tt1525362/>
- [90] AAAS Science Journalism Awards, 2007 online winner. <https://sjawards.aaas.org/awards/2007-online>
- [91] "Divorce Your Car!" by Katie Alvord (Google Books). https://books.google.com/books/about/Divorce_Your_Car.html?id=hSe4AAAAIAAJ
- [92] Christopher Ketcham, The New Republic (2020): 5G safety debate. <https://newrepublic.com/article/157603/5g-going-kill-us-all>
- [93] Scientific American blog: no reason to believe 5G is safe. <https://blogs.scientificamerican.com/observations/we-have-no-reason-to-believe-5g-is-safe/>
- [94] 5G antenna density and exposure (PubMed). <https://pubmed.ncbi.nlm.nih.gov/29655646/>
- [95] Prof. Tom Butler submission on 5G RFR, filed with FCC (2020). <https://ecfsapi.fcc.gov/file/10604943924787/Prof-Tom-Butler-Submission-on-5G-RFR-Final-27-05-2020-1.pdf>
- [96] Millimeter-wave skin penetration research, IEEE. <https://ieeexplore.ieee.org/document/9002324>
- [97] 5G moratorium appeal (saferemr.com). <https://www.saferemr.com/2017/09/5G-moratorium12.html>
- [98] Sen. Richard Blumenthal press release on 5G health questions. <https://www.blumenthal.senate.gov/newsroom/press/release/at-senate-commerce-hearing-blumenthal-raises-concerns-on-5g-wireless-technologys-potential-health-risks>
- [99] Environmental Health Trust: Senate hearing on 5G safety testing. <https://ehtrust.org/health-effects-of-5g-wireless-technology-confirmed-at-us-senate-hearing-after-senator-blumenthal-questions-industry/>
- [100] Washington Post opinion (2020): 5G and economic recovery (subscription). <https://www.washingtonpost.com/opinions/2020/06/04/5g-conspiracy-theories-threaten-us-recovery/>
- [101] NRDC: federal environmental review and 5G. <https://www.nrdc.org/experts/sharon-buccino/5g-coming-your-neighborhood>
- [102] Court ruling on FCC 5G order (NRDC, PDF). https://www.nrdc.org/sites/default/files/fcc-ruling-aug_9_2019.pdf
- [103] Americans for Responsible Technology: about. <https://www.americansforresponsibletech.org/about>
- [104] Children's Health Defense: Hawaii County 5G cease-and-desist. https://childrenshealthdefense.org/news/hawaii-big-island-told-telecom-to-cease-and-desist-5g-deployment/?itm_term=home
- [105] City of Boston comments to FCC (PDF). https://img1.wsimg.com/blobby/go/18add696-2410-4f74-a623-35ee3c12832d/downloads/FCC%252019-226%2520COMMENTS_BostonMA.pdf?ver=1592952452329
- [106] New Hampshire 5G commission final report (2020, PDF). <http://www.gencourt.state.nh.us/statstudcomm/committees/1474/reports/5G%20final%20report.pdf>
- [107] Martin Blank, "Overpowered" (Seven Stories Press). <https://www.sevenstories.com/books/3399-overpowered>
- [108] SEJournal Online main page and archive. <https://www.sej.org/publications/sejournal/overview>
- [109] SEJournal e-newsletter signup. https://visitor.r20.constantcontact.com/manage/optin?v=001xQbTsTOUeGBXOCgjnKCJZXstn5_K7TFbpmPwF7IScRXFaZndG3m1fA4cSK1SlvpD_VZmEwYE0EW_yO07EbCpCU6cqzz2E-xBZw2B2H4CUJDQ%3D