Wireless Radiation

An Undeniable Risk to Human Health

An annotated history of the science compiled by
Grassroots Environmental Education,
a science-based non-profit organization.

Introduction

There are two important conversations regarding wireless technology going on today. The first, carried on by telecom companies, their investors and the media, promises a fantastic new future with breakthroughs in communications, medicine, education, transportation and entertainment...all delivered instantly by a seamless, wireless infrastructure surrounding us everywhere we go. The second, involving medical professionals, public health experts and scientific researchers, concerns a looming public health crisis based on proven biological risks from both short and long-term exposure to radiofrequency (RF) microwave radiation, or "wireless radiation," the foundation of that wireless infrastructure.[1]

And so the race between science and commerce is on, with extremely high stakes for everyone. Will scientists and public health officials be able to make their voices heard before powerful new wireless networks and devices become even more ingrained in the everyday lives of consumers? Will there be enough time to alert the public to the undeniable risk, and compel government to take steps to protect public health?

This is not the first time we've faced questions like these. At one point in time, DDT, asbestos and tobacco were all considered beneficial. Only later, as the research matured and the health impacts became obvious, did we understand the danger of ignoring emerging science and early signs of trouble. Will we make the same mistake again with wireless radiation?

We offer this booklet of scientific information based on independent, peer-reviewed studies so that decision makers at all levels of government can be fully informed about wireless radiation and its impact on human health.

A word about the scientific studies referenced in this booklet:

While some studies on wireless radiation exposure have found no effects, hundreds of studies have found biological effects occurring at levels at or below current U.S. standards. Due to the diverse nature of biological impacts, this is to be expected. The fact is that no single study or group of studies will ever provide explicit "proof of harm" often demanded by industry. That's because individuals are all genetically unique, and the mechanisms of harm operating with exposure to wireless radiation are epigenetic, meaning that the switches that turn the genes on and off – for both adaptation and disease – are unique to each person's genotype and environment.

The tools that researchers have traditionally used to study health risks, such as epidemiological and toxicological studies, were developed with the premise that a particular cause will always lead to a common effect. For example, cigarettes and lung cancer, vinyl chloride and angio-sarcoma of the liver, asbestos and mesothelioma. This premise is not valid for studies of wireless radiation because the operating mechanism of harm – biological effects that cascade at the cellular level and scale up through tissue, organs and organ systems – can lead to the wide array of impacts we see in the studies of wireless radiation.

The wireless industry often portrays this array of different effects, variations in study findings or the failure to precisely duplicate study results as proof that there is "no risk." Understanding that changes at the biological level will inevitably result in a wide variety of potential outcomes in different people based on individual physiology and genetic susceptibility is critical to understanding the danger posed by exposure to wireless radiation.

On February 8, 1996, President Bill Clinton signed the 1996 Telecommunications Act into law, ushering in an era of unparalleled innovation and marketing of wireless communications that has fundamentally changed the way people interact with the world around them. It was a landmark event, hailed by the telecom industry as a great step forward into the future.

Few people outside of the industry knew that Dr. Henry Lai and Narendra Singh at the University of Washington in Seattle had just published a study documenting a breakthrough discovery – single strand DNA breaks resulting from exposure to wireless radiation, the energy produced by virtually all wireless communications devices.[2] DNA strand breaks can impair cell function, change cell structure and even lead to cell death. It's how we age, and how we develop cancer.

> "...biological damage from exposure to wireless radiation was something that electrical engineers and telecom companies had steadfastly claimed was impossible."

The finding was especially remarkable because biological damage from exposure to wireless radiation was something that electrical engineers and telecom companies had steadfastly claimed was impossible. Exposure could heat tissue if an individual got too close to an antenna, the engineers and physicists told legislators and regulators, but non-ionizing radiation was too weak to damage any biological systems.

Lai and Singh couldn't explain exactly how or why the DNA strands were damaged. Was it a direct effect of the radiation? Or did the radiation interfere with the body's normal DNA repair mechanisms? More research was needed.

We are all electric

Unless we happen to have a pacemaker, few of us appreciate the role that electricity plays in our bodies. Human beings evolved in a natural electrical environment. The earth itself is a giant dipole magnet with poles north and south. There are constant oscillations emanating from the earth's core, and a natural static magnetic field that shifts slightly with the seasons. These magnetic fields play an important role in nature, dictating migration patterns and controlling our own circadian rhythms, among many other things.[3]

Like all animals on earth, our biological systems use an interplay of tiny electrical charges and chemical signals to control and direct precise responses to internal and external stimuli, thus influencing function and development. External influences, both chemical and electrical, can interfere with and adversely affect these biological processes. External influences include both natural and man-made electromagnetic fields (EMFs).

While most doctors, public health experts and scientists understand how environmental factors influence our cell biology, there have always been doubts that people could acquire a chronic illness from non-ionizing RF microwave radiation, even at low levels. These doubts have been compounded by decades of sponsored medical research that appears to show no evidence of harm from exposure. But science is unrelenting, and despite the efforts of industry to play down any possible problem, the majority of independent, non-sponsored studies continue to hone in on the role that electromagnetic fields and wireless radiation play in the etiology of disease.

Dr. Robert O. Becker, surgeon and researcher who was twice nominated for the Nobel Prize, observed in 2001, “I have no

doubt in my mind that, at the present time, the greatest polluting element in the earth's environment is the proliferation of electromagnetic fields."[4]

Early studies on wireless radiation and biological effects

The work of Lai and Singh at the University of Washington was not the first study to suggest biological effects from wireless radiation. Studies conducted by the U.S. military between 1940 and 1960 had documented biological effects and impacts on behavior from exposure to wireless radiation.[5] In 1973 the EPA hosted a meeting in collaboration with the American Public Health Association to discuss the growing concern over non-ionizing radiation and its potential impact on human health.

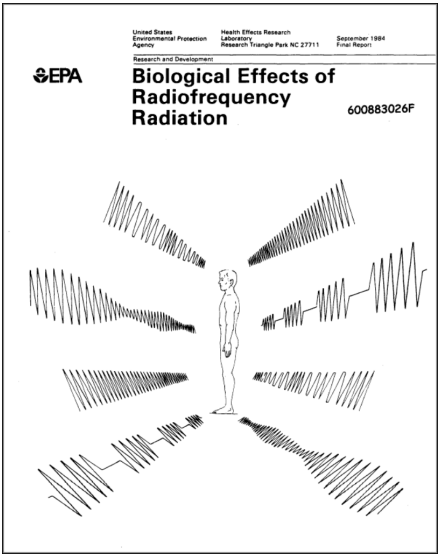
That same year, at an international symposium on the "Biologic Effects and Health Hazards of Microwave Radiation" sponsored by the World Health Organization, the U.S. Department of Health, Education and Welfare, and the Polish Scientific Council to the Minister of Health and Social Welfare, participants discussed the current state of the science regarding the measurement of microwave radiation, clinical manifestations of exposure, neurological findings, health status of microwave workers, blood protein disorders, and the effects of electromagnetic fields in densely populated areas. As one presenter observed, "The reaction of the central nervous system to microwaves may serve as an early indicator of disturbances in regulatory functions of many systems."[6]

In 1977 the Journal of Microwave Power published an article citing new research demonstrating that exposure could affect nervous system function at power levels far below those that could heat tissue.[7]

The electromagnetic spectrum is roughly divided into ionizing and non-ionizing radiation. It is well established that ionizing radiation can cause direct harm by removing electrons from atoms with resultant DNA damage resulting in fixed mutations.[8] It also produces "free radical" molecules (those with an imbalance of electrons) which can cause widespread injury to cell structures via oxidation of tissues and cell death. Non-ionizing radiation acts as an environmental stressor, with direct, toxic oxidative effects on biological processes unrelated to heat or to ionization.[9] The effect of non-ionizing radiation is indirect, inducing biochemical changes in cellular structures and their membranes.[10]

The following year, scientists at the National Institute for Occupational Safety and Health concluded that they had sufficient evidence to announce that exposure to wireless radiation had a biological effect on animals and humans, including damage to major organs, disruption of important biological processes, and the potential risk of cancer.[11]

In 1982 the Environmental Protection Agency's Office of Radiation Programs, which had been studying the non-thermal effects of wireless radiation for a decade, announced that it was developing a federal guidance to limit the public's exposure. But before the Agency was able to develop and implement those guidelines, its authority to do so was rescinded and the office was defunded.



EPA publication on RFR before being defunded

Research continued through the 1980s, much of it focusing on the further effects of thermal heating, particularly an increase in temperature in the tissue, which typically triggers physiological and behavioral thermal regulatory responses. These responses involve neural activities both in the central and peripheral nervous systems.[12] Other researchers looked at disturbances in neuroendocrine functions triggered by exposure to wireless radiation, which are related to stress, alteration in immunological responses, and tumor development.[13]

The industry responds

By 1996, concern about the public's reaction to the growing scientific evidence of potential harm led the telecom industry to craft and lobby for language in the Telecommunications Act that would pre-empt any local interference with the placement of wireless antennas in local communities on the basis of "environmental" factors, a phrase which the telecoms have argued in court, means anything to do with human health.[14]

Later that same year, the recommendations of the International Electrical and Electronics Engineers (IEEE) and a 1986 report from the National Council on Radiation Protection and Measurements (NCRP) regarding the limits to which humans could safely be exposed to wireless radiation were championed by the telecom industry. They were incorporated into the guidelines adopted by the Federal Communications Commission (FCC), where they remain today.[15]

The FCC's guidelines, which ignore decades of published science regarding biological impacts of exposure, are based instead solely on the thermal capacity of wireless radiation, and use the Specific Absorption Rate (SAR) as the means to measure exposure.[16]

Relevant factors which are not considered in the FCC's public exposure guidelines include:

- Simultaneous exposure to multiple microwave frequencies
- Genetic variability/susceptibility
- Age and individual health status
- Synergistic impact of combined toxic exposures
- Unique dosimetric properties of tissues/organs in the body
- Unique vulnerability of children due to their developing physiology
- Critical windows of development in children
- Long-term cumulative exposure impacts

Late 1990s and 2000s: Scientific inquiry continues

Scientific inquiry, meanwhile, continued its slow but methodical progress. Independent researchers, noting the proliferation of wireless networks and devices to which the public was being exposed, sought to understand the impact of this increased exposure on human health.

In 1997, Henry Lai and Narendra Singh published another study, this one showing both single and double-strand DNA breaks with low intensity RF microwave radiation (2450 Mhz with a spatial averaged power of 2mW/cm2; SAR 1.2W/kg.).[17] The following year they repeated the studies, but this time added a group of rats that were given melatonin, a potent free radical scavenger, before and after RF exposure. They found that melatonin seemed to block the adverse effects of the radiation.[18]

In 1998, Dr. Jerry Phillips at the Pettis VA Medical Center in Loma Linda confirmed DNA single-strand breaks exposed to RF microwave frequencies at 813.5 MHz and 836.5 MHz frequencies at a relatively low SAR (average 2.4 and 24 μW/g-1).[19]

In 2004, the Reflex Project, which included 12 research teams in seven European countries, confirmed the ability of low level RF microwave radiation to cause DNA breaks in exposed cells (SAR=0.3 and 2W/kg), as well as its ability to activate a stress response - the production of heat shock proteins. This stress response is a well-documented protective reaction of plant and animal cells to a variety of environmental threats, including high frequency RF radiation.[20]

Dr. Martin Blank and Reba Goodman at Columbia University demonstrated that the stress response was triggered at different RF frequency ranges with different SARs, rendering the SAR measurement questionable as a basis for the development of FCC safety guidelines.[21] This work was confirmed by Dr. Dariusz Leszczynski and his team of researchers at the University of Helsinki in 2004.[22]

In 2007, researchers at the University of Kentucky were able to demonstrate how exposure to RF microwave radiation could damage or even destroy brain cells,[23] and in 2012, a study conducted at Yale University found that pregnant laboratory mice exposed to RF microwave radiation produced offspring that were more hyperactive and had poorer memory compared to the unexposed control group. Dr. Hugh Taylor, Chair of the Department of Obstetrics, Gynecology and Reproductive Sciences at Yale University School of Medicine, examined the brain structure of the exposed animals and discovered significant neuron damage in the prefrontal cortex - the part of the brain that controls behavior – with no such damage in the control group.[24]

"The fetus is perhaps the most vulnerable to these types of insults, when the brain is just forming, when all of the organ systems are just beginning to develop," said Dr. Taylor. "Adults are much more resistant to most types of toxic exposures compared to delicate systems undergoing brand

new development, so we designed the study to look at the effects [of wireless radiation] on the pregnancy and on the developing fetus."

Building on the work of Dr. Taylor, other researchers published similar studies on wireless radiation's impact on brain development, showing that laboratory animals prenatally exposed to the radiation demonstrated impaired learning and also showed damage to those parts of the brain involved in memory.[25] Prenatally exposed rat pups also had damaged spinal cords.[26]

In 2011, the World Health Organization (WHO)/International Agency for Research on Cancer classified RF-EMF (radiofrequency electromagnetic fields) as a Class 2B possible human carcinogen based on credible evidence that linked long term wireless exposure to brain cancer.[27] However, many of the scientists studying microwave radiation felt that the 2B classification should have been stronger, pointing out that five of the six members of the group in charge of the classification were affiliated with the International Commission on Non-Ionizing Radiation Protection (ICNIRP), an organization with deep ties to the telecommunications industry.[28]

Most recently, a ten-year, $30-million-dollar study conducted by the National Toxicology Program of the U.S. National Institutes of Health sought to determine if exposure to wireless radiation from cell phones increased the risk of cancer. The conclusion of a 13-member independent panel of experts in 2018 was that there was "clear evidence of carcinogenicity," the highest level of scientific certainty.[29] They cited an increased incidence of glioma in the brain and malignant schwannoma in the heart. Dr. Ronald Melnick, principal designer of the study, stated, "We should no longer assume that any current or future wireless technology – including 5G – is safe without adequate testing."[30]

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Another study published in 2018 by the Ramazzini Institute in Italy, funded in part by the U.S. government, found that lab animals exposed to wireless radiation from distant cell towers had a greater chance of developing heart tumors than those which were not exposed. This study was the first large-scale study to show clear evidence of cancer risk from far-field exposures.[31]

Other recent studies demonstrate that wireless radiation has broad effects on the body, impacting sperm, ovaries, liver, kidneys, the immune system, melatonin production, the blood brain barrier, and nerve cell viability and function.[32] Prenatal developmental effects are especially worrisome as they can be heritable. The damage to cells is cumulative and increases with longer exposure. Because of long latency periods between exposure and diseases such as brain cancer, the full negative effects of wireless radiation exposure on public health may not be realized for many years.[33]

Acute effects: electro-sensitivity as a clinical diagnosis

Over time, the proliferation of wireless devices and computers has not only revealed a number of significant health impacts, but also an increasingly common and relatively new syndrome called "electro-sensitivity" or "microwave sickness." A growing number of people in all walks of life are reporting a wide range of symptoms, including headaches, dizziness, insomnia, mental confusion, heart palpitations and fatigue in the presence of wireless devices or when in close proximity to cell towers. These are classic signs of microwave sickness described in reports by NASA,[34] the U.S. Department of Defense[35] and the EPA.[36]

The United States Access Board, an independent agency of the United States government devoted to accessibility for people with disabilities, recognizes "that multiple chemical sensitivities and electromagnetic sensitivities may be considered disabilities under the Americans with Disabilities Act (ADA) if they so severely impair the neurological, respiratory or other functions of an individual that it substantially limits one or more of the individual's major life activities."[37]

Over a decade ago, firefighters in California reported the development of symptoms of electro-sensitivity after wireless transmitters were installed on fire stations. They noted severe headaches, sleep deprivation, depression, lack of focus, lack of impulse control, slowed reaction time, tremors and vertigo. The International Association of Firefighters (IAF) commissioned a study to further investigate the issue. The study confirmed adverse effects on the firefighters, and the IAF authored a policy statement asking for exemptions from placement of wireless antennas on their facilities so they could maintain "optimal cognitive and physical capacity at all times."[38]

Research is advancing with evidence that electro-sensitivity may be related to multiple chemical sensitivity (MCS) as a toxic exposure. Biomarkers for electro-sensitivity have been proposed to help better diagnose the condition.[39]

Biological harm to living organisms

Science is revealing harm to many living organisms from exposure to electromagnetic fields and wireless radiation, including trees,[40] plants, animals, insects and bacteria, at levels at or below current U.S. safety guidelines.[41]

In 2013, a group from the Institute of Environmental Sciences in the Netherlands published a thorough review of the ecological

effects of RF-EMF, based on 113 published, peer-reviewed studies. They found that wireless radiation had a significant negative impact on birds, insects, other vertebrates, and multiple organisms and plants in 70% of the studies.[42]

For instance, bees are a critical pollinator species, required for the adequate fertilization of flowers, ensuring that a new generation of seeds and fruit will be produced. New research suggests that the recent decline in wildlife and bee populations may be associated with higher levels of ambient electromagnetic radiation (EMR).[43] Birds and bees use an iron ore mineral called magnetite in their brains for navigation and distant migration. Electromagnetic microwave radiation has been shown to disrupt this process.[44] Research has also demonstrated abnormalities in reproduction and behavior of birds nesting near cell towers.[45]

Industry pushback

Not surprisingly, the wireless industry has pushed back hard against this ever-growing body of independent, peer-reviewed research, commissioning their own studies and questioning the findings and competence of independent scientists. Like the tobacco industry before it, the wireless industry has sought to create sufficient doubt and "scientific controversy" to dissuade federal regulators from reigning in the broad expansion of wireless networks.

Researchers like Henry Lai became concerned about the manipulation of science for profit, and in 2006 he analyzed the available studies on RF microwave radiation between 1990 and 2006, including the source of funding for the studies. He found that 50% of the 326 studies showed a biological effect from exposure to RF microwave radiation and 50% showed no effect. But when he separated the studies based on funding, he found that only 30% of the industry-funded studies showed an effect, while 70% of the independently funded studies showed an effect.[46]

In 2012, the U.S. Government Accountability Office issued a report recommending that the FCC update its human exposure guidelines for RF microwave radiation. The following year, the agency commenced an official review of its exposure policies. Thousands of comments were submitted, including hundreds from independent experts from around the world. The agency closed the inquiry in late 2013, taking the comments under advisement. No acknowledgement of the review was announced.

Recently, members of Congress have demanded to know the results of the inquiry, and why the guidelines haven't been updated. FCC Chairman Ajit Pai has responded with a recommendation that the FCC formalize its long-outdated exposure standards, which, for cell towers, antennas and other wireless infrastructure, are among the least protective in the world.

Conclusion

The notion that exposure to radiofrequency microwave radiation is not harmful to humans, which has been the underlying principle of all federal legislation and regulations regarding wireless technologies for more than twenty years, has now been proven false.

The substantial body of credible science documenting harm from exposure to various levels and frequencies of wireless radiation demand a precautionary approach to the widespread deployment of wireless technologies to reduce potential harm to the public and the environment.[47]

More than 240 scientists with published peer-reviewed research on wireless radiation and human health signed an appeal to the World Health Organization and the United Nations, calling for precautionary health warnings and stronger regulation of wireless radiation.[48]

The rollout of 5G technology will require the deployment of up to one million new "small cell" antennas in neighborhoods across the country, exposing millions of Americans to higher levels of wireless radiation, 24 hours a day, at close proximity.

History teaches us that we ignore science at our peril. The science linking wireless radiation to adverse health outcomes is strong and growing stronger every day. Those with a financial stake in wireless communications may choose to disregard the science; those with the responsibility to protect public health and safety must act with caution, recognizing that wireless radiation is an undeniable risk to our health and the environment.

The Precautionary Principle states, “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically.“[49]

More information

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Digest of Independent Science on Wireless Radiation and Human Health, Grassroots Environmental Education,
http://grassrootsinfo.org/emergingscience.php.

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