



Health Effects of RF-EMF on Humans

Discoveries of the past five years

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Introduction

In this paper we will review some of the more recent publications over the past two years with reference to some older literature. With the roll out of fifth generation (5G) technology the concern over the effects of RF EMF has grown in controversy. Some health protection agencies and scientific advisory committees have deemed there is no concern of harm. However, independent scientific review has determined there is uncertainty and rapidly emerging evidence to the contrary. There is a lack of clarity as to what technology is included in 5G. There is a growing number of laboratory studies documenting disruptive in vitro and in vivo research showing effects but with gaps, a lack of high quality epidemiological studies for 5G specifically, but many for past generations of RF EMF, and persistent allegations that telecommunications regulatory authorities do not base their safety guidelines on the current scientific evidence related to unmanaged conflict of interests [4]. These findings get repeated a lot, so how it is novel to repeat the same thing over and over? It is not. It is simply attempting to make a point that is not being heard by those in the media and those creating legislation and those responsible for the creation of policies.

1 5G

The roll out of 5G has left many people concerned with not only the potential health effects but the legislative accuracy of the safety limits. This new technology that will leave many immersed in high frequency RF EMF with very few "quiet zones" or "safe spaces" could lead to a potential increase in those suffering the effects of RF EMF. The current 5G roll out is below the human exposure limits specified by International Commission on Non-Ionizing Radiation Protection (ICNIRP). These levels; however, are much higher than those shown to have an effect on the following: cell proliferation, genotoxicity, gene expression, cell membrane function, cell signalling and a variety of other effects. Studies that show these effects are often not independently replicated and often employ low quality methods of exposure assessment and control. The lack of accurate and repeated studies can lead to an overall assessment that there are no potential health effects on humans [6]. The concern over the potential health effects for adding

5G to an already concerning amount of RF EMF is growing. The higher frequency means that there needs to be pervasive sources. EMF is becoming known as another form of environmental pollution. Epidemiologically it is next to impossible to test for as there are virtually no control groups and effects are non-linear. A precautionary roll out is highly suggested by Russell [8].

The current findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principles and to define exposed subjects as potentially vulnerable and revise existing limits, in this order. An adequate knowledge of pathophysiological mechanisms linking RF EMF and health risks, particularly the evidences pointing to extrinsic factors as massive contributors to cancer risk and growth of non-communicable diseases [3].

1.1 Conflict of Interests In Science

There is a bias in the research that ties much of it to industry resulting in radical conflict of



interest bias. It is currently labelled as a 'possible carcinogen' Group 2B by Who and IARC. This is being largely ignored by industry guidelines to exposure. Not only that but there is a push to have it moved to Group 1 as a 'human carcinogen'. Many industries such as ICNIRP have continued bias and COIs regarding RF EMF. All that is currently being asked is that there be a moratorium until further research can be conducted [5].

With contradicting study findings to support the possible effect of bias to support the hypothesis, there is evidence that these are a potential issue. Such as the increased risk of glioma and acoustic neuroma, where ICNIRP determined there was no health risk due to exposure. Where the study conducted by Hardell et al did determine a potential relation [5]. Where Hardell points out several flaws in ICNIRPs statements and cited sources. Hardell calls into question the guidelines ability to protect against long term exposures that would lead to cancer, nervous system changes and other potential harm. The authors accuse ICNIRP of several examples of scientific misrepresentation. Such as simply leaving out sources from their studies, shortening study time and using different power levels. Also, that ICNIRP misquotes Hardell's and others studies. The authors state that due to ICNIRPs bias and misinterpretation of study results their publications cannot be used for guidelines [5].

2 Health Outcomes

There are a great many potential health outcomes associated with exposure to RF-EMF but only so much time and funding to research potential avenues. Verbeek et al took the liberty of surveying experts to determine the most important potential outcomes to review. The survey included 164 of 300 surveyed experts who said rated the following as important: cancer, heat-related effects, adverse birth outcomes, electromagnetic hypersensitivity, cognitive impairment,

inauspicious pregnancy outcomes and oxidative stress. Verbeek et al then go on to discuss how it is possible to prioritize the systematical review these outcomes in an inclusive and transparent way. Given a rating of importance system based on the following criteria: evidence from human studies, animal studies, in vitro studies, possible public health impact and public concern. The authors declared several potential competing interests in this survey [11].

Among the greatest concerns are the exposure and health effects of children to ELF and RF sources. The carcinogenicity of these waves is currently unrecognized by WHO. There is no ethical way to conduct a controlled experiment to discern the possibility of negative outcomes on children thus the precautionary approach is suggested. There is a lot of conflicting information regarding the study findings on the potential health effects and scientists urge governing bodies, such as WHO, to continue research. The conflicting information includes development of temporal lobe gliomas and meningiomas compared to brain tumour development. Sensitivity of children to EMF exposures according to WHO is no higher than adults. However, several studies indicating that a child's decreased size, skull thickness, increased moisture and ionic content and lifetime exposures put them at greater risk. Moon determines that children are more vulnerable to the EM wave effects than adults and precautionary principles should be followed regardless of study outcome. Also that the opinions of clinicians should be given more weight than industries in the establishment of policies regarding EMF exposures [?] [7].

Although current exposure levels are well within industry safety standards of thermal effects, the current studies are questioning the possibility of non-thermal effects. Many of previous studies were retrospective and were conducted before mobile phone use reached its current day levels. In 2015 a report from the Scientific Committee on Emerging and Newly Identified Health Risks

for the effects of EMF exposure found that there was no evidence of increased risk of brain tumours and other cancers. However, since then new data, as well as meta-analyses, indicate that long term (over 10 years) exposure increased risk of intracranial tumours, specifically glioma on the ipsilateral side. It has been recommended that a reassessment be conducted and the rating be increased from 2B to 2A "probable carcinogenic" or just 1 "carcinogenic" [2].

2.1 Electromagnetic Hypersensitivity

EHS previously called "Microwave Syndrome" is a clinically diagnosed syndrome characterized by a widespread spectrum of non-specific multiple organ symptoms. It typically includes the central nervous system occurring in patients with acute or chronic exposure to electromagnetic fields (RF, EMF & ELF) in extremely low intensities. Many of the mechanisms described for Multiple Chemical Sensitivity (MCS) apply with modification to EHS. Repeated exposures result in sensitivity and consequent enhancement of responses, often leading to impaired detoxification systems. Many potential mechanisms exist some of which are discussed by Stein et al [10]. The authors suggest that more relevant diagnostic tests are required, exposure limits should be lowered and the spread of global and local wireless networks should be decreased and safer wired networks should be used instead. This would make access to public places more amenable to individuals with EHS [10].

3 Mechanisms

As previously stated, RF EMF has been classified as Group 2B by IARC. The main mechanism for this is the production of stressors ROS (reactive oxygen species) potentially leading to cellular or systemic oxidative stress in cells. The mechanism for altered ROS and reactive nitrogen species levels causing cellular damage on biolog-

ical material eventually leading to many diseases such as: cancer, diabetes, congenital malformations, and neurodegenerative syndromes has already been documented. The production of ROS has also been documented experimentally. However, a complete scientific consensus has not yet emerged for epidemiological associations [9].

The animal studies provided consistent evidence of oxidative stress demonstrated, in rats in the liver and kidneys, and in mice in the brain, testes, liver, kidneys and ovaries. Admittedly some studies contained quantitative or qualitative shortcomings or omissions. A trend is none the less emerging. EMF exposure even in low doses may lead to changes in cellular oxidative balance. Adverse conditions, such as diseases, compromise the body's defence mechanisms, and individuals with pre-existing conditions are more likely to experience health effects [9].

3.1 Diagnosis & Treatment

There have been recommendations for treatment around for several years now. The EUROPAEM has developed guidelines for differential diagnosis and treatment to restore and prevent further issues in individuals suffering from the negative effects of EMF. Up to 45% of people noticed a difference after receiving counselling, such as changing the bedroom, and 2/3rds of individuals chose reduction as a principal tool [1].

The authors suggest that these approaches be brought to the general physicians level for holistic health approach. If EMF related health problems are suspected the recommended approach is the following:

1. History of health issues & EMF exposure
2. Medical examinations and findings
3. Measurements of EMF exposure
4. Reduction & prevention of EMF exposure
5. Diagnosis
6. Treatment of patient and environment

There are questionnaires available to help practitioners in this. Medical examination should

include: NO production, mitochondriopathy, oxidative stress-lipid peroxidation (MDA-LDL), inflammation (TNF- α), IFN-gamma-inducible protein 10 (IP-10), IL-1b, histamine, and melatonin status. A full list of additional suggested diagnostic techniques can be found in the authors study [1].

Treatments should include all de-stressing aspects of health. Adjuvant therapies: drinking water, light, sauna, oxygen, exercise, sleep, protection from blue light, exposure to natural EMFs of the Earth (grounding/earthing) [1].

4 Reality of Exposures

The NTP (National Toxicology Program) and Ramazzini Institute have both reported RF EMF exposure from cell phones, specifically, lead to negative impacts on animal cells and cognitive/behavioural development in children. Case control studies have found risks of glioma and schwannoma localized to cell phone use sites. Cell phones that are manufactured to be within SAE (Specific Absorption Rate) limits. Limits that are set outside or standard use of cell phones. There is a stack up of potential increased risk to users health. The authors suggest a change to public

health guidance regarding cell phones [12].

4.1 Measurement & Wearables

Zradzinski et al complete a study using a wearable detector they created for the purpose of the study. They utilized it on the head and completed measurements for exposures at various depths of tissue. Their conclusion is that the best use of devices such as these should be to inform workers of potential exposures and be worn upon the head. The authors admit that it was not possible to determine best use or exposure under the current testing methods. Such as taking into account anatomical measurements on other parts of the human body. Including various antenna and device ground planes would also be helpful. Wearing a device closer to the body may cause an increase in power in order for device to function as desired. This means a higher SAR value [13].

A solution for this issue is to design devices to function well on the body without increasing the power output levels. Such as new antenna designs, materials and overall device designs should be improved for optimized radio links [13].

References

- [1] I. Belyaev, A. Dean, H. Eger, G. Hubmann, R. Jandrisovits, M. Kern, M. Kundi, H. Moshhammer, P. Lercher, K. Muller, G. Oberfeld, P. Ohnsorge, P. Pelzmann, C. Scheingraber, and R. Thill. Europaem emf guideline 2016 for the prevention, diagnosis and treatment of emf-related health problems and illnesses. *Rev Environ Health*, 31(3):363–97, 2016. 2191-0308 Belyaev, Igor Dean, Amy Eger, Horst Hubmann, Gerhard Jandrisovits, Reinhold Kern, Markus Kundi, Michael Moshhammer, Hanns Lercher, Piero Muller, Kurt Oberfeld, Gerd Ohnsorge, Peter Pelzmann, Peter Scheingraber, Claus Thill, Roby Journal Article Review Germany 2016/07/28 Rev Environ Health. 2016 Sep 1;31(3):363-97. doi: 10.1515/reveh-2016-0011.
- [2] A. Bortkiewicz. *Health effects of Radiofrequency Electromagnetic Fields (RF EMF)*, volume 57, pages 403–405. 2019.
- [3] A. Di Ciaula. Towards 5g communication systems: Are there health implications? *Int J Hyg Environ Health*, 221(3):367–375, 2018. 1618-131x Di Ciaula, Agostino Journal Article Review Germany 2018/02/07 Int J Hyg Environ Health. 2018 Apr;221(3):367-375. doi: 10.1016/j.ijheh.2018.01.011. Epub 2018 Feb 2.
- [4] J. W. Frank. Electromagnetic fields, 5g and health: what about the precautionary principle? *J Epidemiol Community Health*, 2021. 1470-2738 Frank, John William Orcid: 0000-0003-3912-4214 Journal Article Review England 2021/01/21 J Epidemiol Community Health. 2021 Jan 19;jech-2019-213595. doi: 10.1136/jech-2019-213595.
- [5] L. Hardell and M. Carlberg. Health risks from radiofrequency radiation, including 5g, should be assessed by experts with no conflicts of interest. *Oncol Lett*, 20(4):15, 2020. 1792-1082 Hardell, Lennart Carlberg, Michael Journal Article 2020/08/11 Oncol Lett. 2020 Oct;20(4):15. doi: 10.3892/ol.2020.11876. Epub 2020 Jul 15.
- [6] K. Karipidis, R. Mate, D. Urban, R. Tinker, and A. Wood. 5g mobile networks and health—a state-of-the-science review of the research into low-level rf fields above 6ghz. *J Expo Sci Environ Epidemiol*, 31(4):585–605, 2021. 1559-064x Karipidis, Ken Orcid: 0000-0001-7538-7447 Mate, Rohan Urban, David Tinker, Rick Wood, Andrew Journal Article Research Support, Non-U.S. Gov't Review 2021/03/18 J Expo Sci Environ Epidemiol. 2021 Jul;31(4):585-605. doi: 10.1038/s41370-021-00297-6. Epub 2021 Mar 16.
- [7] J. H. Moon. Health effects of electromagnetic fields on children. *Clin Exp Pediatr*, 63(11):422–428, 2020. 2713-4148 Moon, Jin-Hwa 2019R1F1A1058704/National Research Foundation of Korea/ HY-2016/Hanyang University/ Journal Article 2020/07/21 Clin Exp Pediatr. 2020 Nov;63(11):422-428. doi: 10.3345/cep.2019.01494. Epub 2020 May 26.
- [8] C. L. Russell. 5 g wireless telecommunications expansion: Public health and environmental implications. *Environ Res*, 165:484–495, 2018. 1096-0953 Russell, Cindy L Journal Article Netherlands 2018/04/16 Environ Res. 2018 Aug;165:484-495. doi: 10.1016/j.envres.2018.01.016. Epub 2018 Apr 11.
- [9] D. Schuermann and M. Mevissen. Manmade electromagnetic fields and oxidative stress—biological effects and consequences for health. *Int J Mol Sci*, 22(7), 2021. 1422-0067 Schuermann, David Orcid: 0000-0003-2904-1378 Mevissen, Meike Journal Article Review 2021/05/01 Int J Mol Sci. 2021 Apr 6;22(7):3772. doi: 10.3390/ijms22073772.

- [10] Y. Stein and I. G. Udasin. Electromagnetic hypersensitivity (ehs, microwave syndrome) - review of mechanisms. *Environ Res*, 186:109445, 2020. 1096-0953 Stein, Yael Udasin, Iris G Journal Article Research Support, Non-U.S. Gov't Netherlands 2020/04/15 Environ Res. 2020 Jul;186:109445. doi: 10.1016/j.envres.2020.109445. Epub 2020 Mar 30.
- [11] J. Verbeek, G. Oftedal, M. Feychting, E. van Rongen, M. Rosaria Scarfi, S. Mann, R. Wong, and E. van Deventer. Prioritizing health outcomes when assessing the effects of exposure to radiofrequency electromagnetic fields: A survey among experts. *Environ Int*, 146:106300, 2021. 1873-6750 Verbeek, Jos Oftedal, Gunnhild Feychting, Maria van Rongen, Eric Rosaria Scarfi, Maria Mann, Simon Wong, Rachel van Deventer, Emilie World Health Organization/International Journal Article Research Support, Non-U.S. Gov't Netherlands 2021/01/06 Environ Int. 2021 Jan;146:106300. doi: 10.1016/j.envint.2020.106300. Epub 2020 Dec 11.
- [12] S. Wall, Z. M. Wang, T. Kendig, D. Dobraca, and M. Lipsett. Real-world cell phone radiofrequency electromagnetic field exposures. *Environ Res*, 171:581–592, 2019. 1096-0953 Wall, Stephen Wang, Zhong-Min Kendig, Thomas Dobraca, Dina Lipsett, Michael Journal Article Research Support, Non-U.S. Gov't Netherlands 2018/11/19 Environ Res. 2019 Apr;171:581-592. doi: 10.1016/j.envres.2018.09.015. Epub 2018 Oct 3.
- [13] P. Zradzinski, J. Karpowicz, K. Gryz, L. Morzynski, R. Mlynski, A. Swidzinski, K. Godziszewski, and V. Ramos. Modelling the influence of electromagnetic field on the user of a wearable iot device used in a wsn for monitoring and reducing hazards in the work environment. *Sensors (Basel)*, 20(24), 2020.