

COMMENT

Notes on parliament hearing in Tallinn, Estonia June 4, 2019 as regards the deployment of the fifth generation, 5G, of wireless communication

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Abstract. The fifth generation (5G) for wireless communication is about to be deployed worldwide in spite of no thorough studies being made on the potential risks to human health and the environment. The implementation seems to be driven mainly by business interests, not considering mounting public anxiety on the associated risks. In Estonia, an appeal on a moratorium was signed by 1,122 subjects, forcing a hearing in the Social Affairs Commission and the Environment Commission of Estonian Parliament on June 4, 2019. The hearing lasted for 1 h and 40 min. The whole hearing may be found on the web. It clearly demonstrated that decision-making bodies base their decisions and act on expert statements that tend to be biased and formed by a cartel of members instead of their own science-based evaluation. Thus, the hearing revealed a lack of knowledge among the Commission members on the risks involved with the use of 5G wireless communication that is exemplified herein. This may create negative consequences for human health and the environment in the future.

Introduction

It seems as if the majority of decision-makers, such as politicians, are not informed and educated about the risks to human health and the environment from radiofrequency (RF) radiation. Instead, if anything, they rely mainly on evaluations made by different organizations with inborn conflicts of interest, as outlined (1,2). One such organization is the International Commission on Non-Ionizing Radiation Protection (ICNIRP) that has repeatedly ignored scientific evidence on the adverse

risks of RF radiation to humans and the environment. The majority of countries use their unscientific evaluation relying only on the thermal (heating) paradigm for biological effects. This is done in spite of clear scientific evidence on so-called non-thermal effects as outlined below. The 13 commissioners of the ICNIRP should be responsible for that malpractice.

With this background, a comment on the hearings on the fifth generation, 5G, for wireless communication in the Estonian Parliament is presented herein. Clearly the majority of the attending persons seemed to be not well-educated on decision-making regarding this issue. Their guidelines mainly rely on evaluations by ICNIRP and similar organizations, with many members included in the ICNIRP cartel (<https://www.saferemr.com/2018/07/icnirps-exposure-guidelines-for-radio.html>). In May, 2011 RF radiation in the frequency range of 30 kHz-300 GHz was classified by the International Agency for Research on Cancer (IARC) at WHO as a 'possible' human carcinogen, Group 2B (3,4). The author was part of the evaluation group. This frequency range includes 5G. Since then, the evidence has strengthened based on human epidemiological and laboratory-based studies [for discussion see (5,6) and animal studies (7-9)]. RF radiation may now be classified as a human carcinogen, Group 1 (10). That is the strongest classification similar as for e.g., 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), asbestos and smoking.

In spite of the IARC cancer classification, little or mostly nothing has been done to reduce RF radiation exposure worldwide, including advice to the population on precaution. By contrast, ambient RF radiation is expected to increase with the introduction of 5G. No doubt, the exposure guidelines by ICNIRP based only on the short-term thermal effects of RF radiation, have been contra-productive to public health and are outdated. These guidelines were initially published in 1998 (11) and reproduced in 2009 (12), still not considering the non-thermal health effects of RF radiation. In fact, ICNIRP has tried to harmonize their guidelines worldwide, including Estonia and the Nordic countries. In spite of increasing evidence on the adverse effects on human health and the environment, ICNIRP still has the view that only thermal effects exist for RF radiation in contrast to the majority of scientists in

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this field. This was presented by the ICNIRP chairman, Eric van Rongen, at a meeting held on April 17, 2019 (<https://www.anfr.fr/fileadmin/mediatheque/documents/expace/workshop-5G/20190417-Workshop-ANFR-ICNIRP-presentation.pdf>).

Furthermore, van Rongen stated that there is no evidence that RF radiation causes such diseases as cancer and that the US National Toxicology Program (NTP) (7,8) and Ramazzini Institute (9) studies are not convincing for carcinogenesis. These statements are most remarkable and on the contrary to sound scientific evidence. This is opposite to the evaluation of 252 scientists from 43 nations with >2,000 publications in this research field (www.emfscientist.org).

Recently, ICNIRP published a note on the NTP (7,8) and Ramazzini Institute (9) animal studies (13). This note is based on the view by the 13 Commission members and represents the misconception and wrong evaluation of these studies; for example it is claimed that the histopathological evaluation was not blinded, a false statement. ICNIRP also claims that there is no verified mechanism for RF radiation carcinogenesis in spite of well-designed studies showing the contrary, e.g., oxidative stress (14) and DNA damage (15). There are also several other wrong suggestions, such as that some of the NTP findings were due to heat caused by RF radiation. On the contrary, heat is not a known carcinogen. The wrong statements by ICNIRP have already been rebutted (16). Of note, the NTP study has now published results on the genotoxicity of mobile phone RF radiation in male and female rats and mice following subchronic exposure. In conclusion, the results revealed that exposure to RF radiation is associated with an increase in DNA damage (17).

The fifth generation (5G) for wireless communication will differ from the previous ones, such as 2G, 3G and 4G. In April, 2019 an 'In-Depth Analysis' on 5G deployment was published by the EU with the recommendation that *Long-term technology research is essential* (please visit: [https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL_IDA\(2019\)631060_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL_IDA(2019)631060_EN.pdf)).

This document has gained remarkably little attention in the media or by organizations and politicians in different countries setting guidelines for the deployment of 5G. The implementation of 5G seems to continue on its own track orchestrated by the industry, the affiliated scientists and politicians. The majority of governments and politicians seem only to consider the thermal effects of RF radiation and furthermore, seem to be uninformed about the technical aspects of 5G. These differ from the previous generations. The 5G appeal to the EU in September, 2017 (www.5Gappeal.eu) currently signed by >260 scientists and medical doctors, requesting for a moratorium on 5G deployment until research on risks has been performed, has had no impact on halting the progress of this technology. The majority of the scientists endorsing the appeal have each made considerable research on this topic in contrast to the 13 ICNIRP commissioners.

No doubt there is increasing concern among individuals worldwide as to the health risks associated with the use of 5G. In Estonia, an appeal on a moratorium was signed by 1,122 subjects, forcing a hearing in the Social Affairs Commission and the Environment Commission of Estonian Parliament on June 4, 2019. The hearing lasted for 1 h and 40 min, of which 20 min were allocated to the organizers

of the appeal. In addition, 10 min were allocated to the Estonian Health Board (Elena Tomasova), the official of the commission (Hele Evarus), and another 10 min were allocated to Lauri Kütt from Tallinn Technical University, which has developed a test 5G network at its campus. Commissions had also invited the Estonian Association of Information Technology and Telecommunications (ITL) and the Association of Estonian Cities and Rural Municipalities (AECM) to participate in the hearing. ITL and AECM representatives had 5 min each to add their points of views; AECM remained passive as they did not have a formed opinion about the topic. The Commissions have 6 months duration to develop their decision on the matter.

The parliament hearing: Minutes of the Joint Session of the Environment Commission of the Riigikogu and the Social Affairs Commission

Below, a short overview of some parts of the presentations is presented, including some notes made during the hearing. The hearing was recorded in its entire length and is published by the Parliament's official YouTube channel, entitled '5G tehnoloogias, 4.05.2019' (<https://www.youtube.com/watch?v=fa26y5nbVOU&list=PLU985AFYCOtNOPxTz2Q7pJPYuIchma5BY>).

Dr Lennart Hardell. In my speech, I discussed the IARC classification on RF radiation as a possible human carcinogen, Group 2B (3,4). This applies to all sources of radiation in the frequency range 30 kHz to 300 GHz and also encompasses 5G at all presently discussed frequencies.

A previous meta-analysis of epidemiological studies on the glioma risk associated with the ipsilateral cumulative use of mobile phones $\geq 1,640$ h yielded a statistically significant increased risk with odds ratio (OR), 2.54; 95% confidence interval (CI), 1.83-3.52 (Table I). Only the Hardell group also assessed the use of cordless desktop phones (DECT). The results are similar by the different study groups. It should be noted that in the study by Coureau *et al* (18), the highest exposure group was ≥ 896 h. This table is taken from a previous publication of the author (19).

Similar updated results are shown for acoustic neuroma in Table II. A meta-analysis of ipsilateral cumulative use $\geq 1,640$ h yielded an OR of 2.71 and a 95% CI value of 1.72-4.28. These results are discussed in greater detail in the study by Belpomme *et al* (5). Again, this table is derived from a previous publication of the author (19).

An 'In-Depth Analysis' on 5G deployment by the EU ([https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL_IDA\(2019\)631060_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL_IDA(2019)631060_EN.pdf)) was requested by the European Parliament's Committee on Industry, Research and Energy (State of Play in Europe, USA and Asia). Presented below are some important statements in the document:

'Long-term technology research is essential. One key problem is the unusual propagation phenomena, especially controlling and measuring RF EMF [electromagnetic field] exposure

Table I. Numbers of exposed cases (Ca) and controls (Co) and odds ratios (ORs) with 95% confidence intervals (CIs) for glioma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

Study	All			Ipsilateral		
	Ca/Co	OR	95% CI	Ca/Co	OR	95% CI
INTERPHONE (28), 2010 Cumulative use, $\geq 1,640$ h	210/154	1.40	1.03-1.89	100/62	1.96	1.22-3.16
Coureau <i>et al</i> (18), 2014 Cumulative use, ≥ 896 h	24/22	2.89	1.41-5.93	9/7	2.11	0.73-6.08
Hardell and Carlberg (29), 2015 Cumulative use, $\geq 1,640$ h	211/301	2.13	1.61-2.82	138/133	3.11	2.18-4.44
Meta-analysis Cumulative use, $\geq 1,640$ h ^a	445/477	1.90	1.31-2.76	247/202	2.54	1.83-3.52

^aCoureau *et al* (18), ≥ 896 h. This table is taken from a previous study by the author (19).

Table II. Numbers of exposed cases (Ca) and controls (Co) and odds ratios (ORs) with 95% confidence intervals (CIs) for acoustic neuroma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

Study	All			Ipsilateral		
	Ca/Co	OR	95 % CI	Ca/Co	OR	95% CI
INTERPHONE (30), 2011 Cumulative use, $\geq 1,640$ h	77/107	1.32	0.88-1.97	47/46	2.33	1.23-4.40
Hardell <i>et al</i> (31), 2013 Cumulative use, $\geq 1,640$ h	27/301	2.40	1.39-4.16	19/133	3.18	1.65-6.12
Meta-analysis Cumulative use, $\geq 1,640$ h	104/408	1.73	0.96-3.09	66/179	2.71	1.72-4.28

This table is taken from a previous study by the author (19).

with MIMO [Multiple Input Multiple Output] at mmWave frequencies for the handset and the base station.

Rather than transmitting a wide area broadcast spread over a segment of the cell around a base station, an 'active antenna' technique is used to form a set of steerable radio beams with power focused on a small area - the receiving handset.

Significant concern is emerging over the possible impact on health and safety arising from potentially much higher exposure to radiofrequency electromagnetic radiation arising from 5G. Increased exposure may result not only from the use of much higher frequencies in 5G but also from the potential for the aggregation of different signals, their dynamic nature, and the complex interference effects that may result, especially in dense urban areas.

The 5G radio emission fields are quite different to those of previous generations because of their complex beamformed transmissions in both directions - from base station to handset and for the return. Although fields are highly focused

by beams, they vary rapidly with time and movement and so are unpredictable, as the signal levels and patterns interact as a closed loop system. This has yet to be mapped reliably for real situations, outside the laboratory'.

No doubt there is increasing concern among individuals worldwide as to the health risks associated with the use of 5G. Millimeter waves (MMWs) have low penetration depth into the body. Primarily, skin and ocular effects have been observed. MMWs may have effects on nerve endings and capillaries in the skin and through these, they may influence deeper structures and functions in the body (20,21). Sweat ducts in the skin may act as helical antennas and respond to MMWs for penetration (22,23); however, this would only display a small exposure enhancement. MMWs can also exert effects on bacterial growth and can augment antibiotic resistance (24), which can lead to difficulties in the treatment of severe infections. A previous study demonstrated an increased risk for permanent tissue damage (25). However, the literature on the health risks associated with the use of 5G is limited and currently, at least to the best of my knowledge, there is

no research available to indicate that 5G is safe. In fact, 5G is marketed by engineers to the public as a spectacular change involving remarkable innovation.

Dr Martin Pall, Professor Emeritus (Washington State University, Portland, USA). In addition to myself, Professor Pall was invited as a speaker. The complete speech is accessible on the web. (<https://www.youtube.com/watch?v=fa26y5nbVOU&list=PLU985AFYCOtNOPxTz2Q7pJPYuIchma5BY>). In the following a short summary is presented.

Professor Pall provided specific linkage of low-intensity EMF exposures to biochemical and physiological changes. Evidence on oxidative stress/free radical-induced damage, excessive intracellular calcium levels, mutational DNA effects, NF- κ B elevation and apoptosis (programmed cell death) was presented. Searches of the PubMed database, the most commonly used database on health and disease, clearly demonstrate that there is a large scientific body of literature linking the causation of these diseases to RF radiation.

5G RF radiation exposures are predicted to be particularly damaging due to the extraordinary level of pulsation that it will inevitably entail. The population of Estonia and of all countries that install 5G, are at risk of the following 6 different RF radiation-related effects: i) Cancer, particularly cancer-derived cell types that are near the surface of the body, producing certain types of cancer, such as melanoma, leukemia and lymphoma; ii) possible universal or near universal early-onset Alzheimer's and other types of dementia; iii) possible universal or near universal autism, caused by perinatal exposures; iv) mutational effects with germ-line mutations causing a number of severe mutations in newborns; v) decreases in reproduction in addition to the reproductive effects that have already occurred from already existing exposure; vi) increases in neurological/neuropsychiatric effects in addition to the widespread and increasingly severe effects that have already occurred from existing exposure.

Dr Lauri Kütt (LK; Professor, Tallinn University of Technology). According to LK *'There are two research committees and organisations, which the European Union considers. One is ICNIRP and the other is, let's say, a committee related to dangers of prospective technological solutions. Neither of these has raised a concern that 5G could give us additional conditions that could be a further threat to health'*.

Comment: This expert opinion is solely based on ICNIRP and Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Therefore, they have not questioned the scientific accuracy or validity of the findings of these bodies and offer no scientific expertise of their own as they rely on other expert bodies. Both ICNIRP and SCENIHR have been criticized for the selective inclusion of the scientific literature as their bases for the no-risk paradigm (1,2). Furthermore, SCENIHR is dated January 20, 2015 and does not discuss the technical matter and higher frequencies of 5G at all. The latest opinion of ICNIRPs was published in 2009 (12).

LK: *'We are now talking a little bit about 5G communication technologies and, in such a relatively neutral way, we are not going to take the technical details here now, but after we are happy to answer questions. Let's just say, that 5G is not something new. It uses relatively similar principles, though, let's say that there are assumptions that we can cope with not larger field strengths, but with smaller field strengths'*.

Comment: In fact, 5G is different from previous mobile communications, as it creates beams, although this method is already used in some countries e.g., Australia for 4.5G systems. 4.5G is also known as 'pre5G', which uses some key 5G technologies while being provisioned over existing 4G user equipment. From a health perspective, the radical difference of 5G will be i) wider bandwidth; and ii) millimeter wave carrier frequencies. These are totally new exposure scenarios for the population. Thirdly, the 5G network plans to exponentially increase the number of devices connected to the network; this elevates the population exposure to an even greater extent.

LK: *'We are here to clarify that at this point, again, it has not been possible to find valid and repeatable scenarios that can confirm that this thing is more dangerous, this 5G thing, than some other communication technology'*.

Comment: In fact, since 5G devices have not yet been deployed, no studies on these exist.

LK: *'Yes, there are certain precautions that can be brought out, which are also mentioned by different recommendations, but that it now would be so dangerous that it should be strictly forbidden, that situation we obviously would not (be) able to explain (give a cause for). In conclusion then, firstly, 5G technology is nothing revolutionary'*.

Comment: The public appeal for the hearing was regarding the request to halt the deployment of 5G until the health effects are investigated. No request to 'strictly forbid' the technology has been presented. LK portrays the requester as anti-technology-minded.

Mr Tõnu Nirk (TN; Head of Communications Department of the Ministry of Economic Affairs and Communications).

TN: *'So, we are following developments and certainly this is an important issue and we will continue to rely on our partners in Estonia, the European Union and the UN on a global scale. The area of law is very flexible and states explicitly that the frequency authorization can impose additional requirements for the protection of human life and health, but not only for the protection of the environment and for any other so-called 'specific cases' as well as public policy, etc. And if the limits change, the frequency authorizations can also be modified to the point where the Consumer Protection and Health Board even has the power to withdraw this frequency authorization if the applicant's activities could endanger human health or the environment. So, we are following developments and certainly this is an important issue and we will continue to rely on our partners in Estonia, the European Union and the UN on a global scale'*.

Comment: These are general statements that clearly demonstrated that the Government relies on outdated evidence on the risks provided by e.g., ICNIRP and SCENIHR as discussed elsewhere (1,2).

Mr Urmas Ruuto (UR), Mr Priit Roosipuu and Mr Jüri Jõema (Representatives of the Estonian Association of Information Technology and Telecommunications).

According to UR *'The concern (that was presented) here was that the signals with 5G are more sophisticated/complicated. Again, there is nothing new in this respect between 3G, 4G, 5G. Modulations, etc., are basically already tested. The same 31/2 GHz was introduced in Estonia in 2006 or 2007 in the form of WiMax. So, we've had it here for almost 10 years. And when we talk about these antennas, then again, originally, we used antennas that radiated 360° in every direction. Then we went to sector antennas where we only radiated to 120°. The point is not to cause such unnecessary radio pollution around you. And now, the next generation should actually take this step further, so we make those antennas 'smart' and we only emit the signal to those users who need it, and the surrounding levels can be much lower'*.

Comment: This statement is not correct. 5G is a new technology that has not been tested.

Priit Roosipuu (PR). According to PR: *'It should also be mentioned that we could be open to new technologies because they are more efficient and allow us to take down old technologies that are less effective. For example, comparing GSM, the second generation, with 4G, we have come down about 100 times in signal sensitivity, so the user needs about 100 times weaker signal to retrieve their data'*.

Comment: Seems more or less right. The hypothesis is that the smartphone is able to receive download signals in significantly weaker signal conditions. However, when the network provides a poor reception level, the mobile phone automatically increases its output power in order to achieve a connection with a base station. This also results in a significantly increased exposure level to the mobile phone user.

Jüri Jõema. Abstained from speaking.

Dr Tarmo Koppel (TK; Tallinn University of Technology).

TK noted *'First of all, I would like to comment on the answers that my colleagues have given, saying that 5G is not technologically very different. As 26 GHz is introduced, then we haven't really used such frequencies before, with exception to some links that however haven't been used by civilian population. With the current technology, like 4G, at 2600 MHz, the wavelength is about 11 cm. If we now adopt 26 GHz, which I understand has not yet been announced, but it is planned by the European Union, then its wavelength is 10 times shorter, about 1 cm. This is a significant difference for a human being because the wavelength is so short that it could enter the human body through the nose, mouth and ears. So public exposure conditions considering this new frequency change very much. We have very little information on how millimeter waves actually affect human health. We,*

who are studying the health effects of electromagnetic fields, are not opposed to advances in technology. We are definitely in favor of technology and innovation. The only idea we would like to convey at this meeting is that this development should be in line with human health and responsible towards human population'.

'My suggestion would be to involve safety specialists in the development of these technologies in order to find solutions where the exposure would be minimal, to develop a 5G that is much lower in exposure than the current 2G, 3G and 4G technologies'.

'The government is in the process of drafting the National Health Plan for 2020-2030, which clearly states that we aim to create a coherent, comprehensive and forward-looking vision of health challenges and opportunities in Estonia and to maintain and improve people's health, increase life expectancy and reduce premature morbidity and mortality; and health inequalities'.

Ms. Astrid Vaiksaar (AV; Organizer of the Appeal).

According to AV *'I am not a scientist, but I have read a lot of research papers and summaries of them. And that is also the reason why we are here today. For me, it is a very big case that 230 scientists around the world come together about the health effects of electromagnetic radiation in 2015 and make a joint statement to the UN asking for a revision of safety standards'*.

'But what radiation does, and the fact that our country absolutely does not inform its inhabitants about i.e. the use of mobile phones. Every mobile phone comes with a guide that tells you not to put it too close to your head, distance should be 1 to 1.5 cm. This is stated in the instruction manual. But in our country people do not know this'.

'But no one has informed me of the potential dangers of this technology, nor has anyone asked me for my consent as to whether I would be willing to live in such an environment. And do I agree to be a test subject for the development of telecoms technology. And, as Lauri Kütt said, it's not telecom companies that want 5G, but devices want to get connected. Like, really? Actually, we should consider what does an ordinary human being want. And sorry, self-driving cars, which is a major selling item, well, who really needs them, right?'

Mr. Peeter Ernits (member of the parliament, Conservative People's Party of Estonia, Environment Committee).

According to Peeter Ernits *'The talk of professor Hardell is very influential. As a geneticist I myself in my work have attacked genes with radioactive substances and antibiotics. I know, how easily these mutations can appear. Studying micro-organisms is much easier than studying rats or humans. But, if already today we know that the aggressiveness increases and reproductive potency decreases (referring to microwave studies), then there is no significant difference in between rats and humans. Then indeed, I would not like to be as a guinea-pig in the extensive network of telecom'*.

Mr. Viktor Vassiljev (member of the parliament, Estonian Centre Party, Social Affairs Committee). According to Viktor Vassiljev 'today I got assurance that the thing is not dangerous'.

'We can not get against the progress'.

'We could also forbid cars (implying that these could pose danger)'.

'As long it is not possible to forbid (5G), one should use individual protection measures'.

Dr Hele Everaus, Professor Emeritus (HE; member of the parliament, Estonian Reform Party, Social Affairs Committee). According to HE 'It's proven today that we cannot absolutely derive conclusion from animal testing to humans - therefore many problems in medicine aren't solved today as we try to find solutions for humans from mice'.

'A colleague made an example how sperm was impacted by different radiations outside of body, this is not a natural internal (body) reaction and hence we can't make conclusions based on that. But what is most important is that nature is way smarter than us and we still don't know the reasons behind most chronic serious disease in medicine, they offer this or that but let's take cancer as an example, But we do not know what causes cancer. There is no such person in the world. We may have theories and hypothesis, like this EMF-s or chemicals.... This means we have very many questions and we need to ask. Today's discussion is very good and perhaps the truth is in this that we shouldn't blindly trust each new technology, but we shouldn't also mistrust as why stop our progress? ...No real scientist knows why cancer, Alzheimer's disease or degenerative nervous system diseases develop'.

Comment: The risk of Alzheimer's disease, neurological/neuropsychiatric effects, autism and reproductive effects, were extensively documented in written materials provided to Dr Everaus and all other members of the commissions. In addition, oxidative stress/free radical damage, excessive intracellular calcium levels, mutational DNA effects, NF- κ B elevation and apoptosis (programmed cell death) were documented. However, Dr Everaus argues that no such literature exists on any of these linkages to each of these chronic diseases. These statements by Dr Everaus are clearly contradicted by scientific literature reviews including, in many cases, thousands of scientific published studies in the PubMed database. It follows that the statements by Dr Everaus must be considered a major lack of knowledge, which is of large concern in a decision-making body, as other members of the commission clearly asked for Dr Everaus to express her expert opinion. Thus, it is not correct to state that nothing is established with regard to the causation of chronic diseases and that no real scientist knows why cancer, Alzheimer's disease or degenerative nervous system diseases develop.

Mrs. Jelena Tomasova (JT; Deputy Director General for Health Protection at Health Board). According to JT: 'In theory 5G network isn't much different from 4G, it's about

electromagnetic fields and the bigger number '5' doesn't indicate automatically bigger EM radiation'.

Comment: This is in contrast to the EU document on 5G Deployment (see above) and not correct. 5G is technically different to the previous generations with complex beam-formed transmissions in both directions, from base station to handset and for the return. Although fields are highly focused by beams, they vary rapidly with time and movement and are thus unpredictable.

JT: 'About 5G technology I should say that there are no longitudinal and reliable studies about its health effects and there can't be any as it is a new technology. Hence it is not possible to make any conclusions about 5G's health effects, neither positive nor negative before the entire configuration is in place, frequencies, parameters of the antennas, the density of antenna deployment..., how close to people they will be installed, how the 5G mobile network shall function inside buildings, how the signal shall reach people etc'.

Comment: This is correct. However, it is a misconception that it cannot be studied before the deployment of 5G. There are numerous laboratory and field studies that can be performed, which is what is being requested in the 5G Appeal (www.5gappeal.eu), namely requesting for a moratorium on the implementation until further investigation.

JT: 'The limiting values in Estonia are regulated with Minister of Social Affairs' act number 38 which is about the limiting values of non-ionizing radiation in living, working and resting areas and in public buildings'.

Comment: This is based on the wrong thermal paradigm on biological effects.

JT: 'In reality we have done a lot of research including measurements, we choose [locations], assess where is potential risk, or from where the biggest number of people turn to us and if I make a summary of that work then I must say that the situation isn't bad and according to all the studies the power density of EMFs remains 1000 times lower in normal living environment than the most rigid limiting value for mobile frequencies'.

Comment: This is interesting, but seems to be unpublished data.

JT: 'In assessing the health impacts of EMFs, the Health Board is relying upon the assessments of international reliable organizations such as WHO and SCENIHR by EU who summarize all the research that is made, analyze them and make a conclusion'.

'Given the rapid increase of the levels of EMFs in living and working environment and given the limited research base and contradicting research about the effects we cannot make final conclusions about its safety. WHO and EU advise to implement precautionary principle and reduce the EMF fields to the minimum where possible. International committee

of non-ionizing radiation [ICNIRP] has recently began to review the guidelines of EMF levels with a purpose to adjust the limiting values if necessary. If this happens, then Health Board together with the Ministry of Social Affairs will review our norms and adjust them according to the suggestions made by internationally acknowledged organizations'.

Comment: On July 11, 2018, the ICNIRP released a draft on guidelines for limiting the exposure to time-varying electric, magnetic and electromagnetic fields (100 kHz to 300 GHz). It was open for public consultation until October 9, 2018. Appendix B was based on the assessment of health risks based on a literature survey (<https://www.icnirp.org/en/activities/public-consultation/index.html>). ICNIRP disregarded the latest animal studies (7-9) on carcinogenesis. The final new ICNIRP guidelines remain to be published. Since the ICNIRP draft voluntarily or by ignorance excluded science-based evidence on health hazards from RF radiation numerous rebuttals were sent to ICNIRP. Whether these comments are included in the final document or not is unknown.

Additional comment: Thus, *'in theory 5G does not differ from 4G'*. This is an incorrect statement as described above. Furthermore, *'there couldn't be any health studies as we are dealing with new technology'*. This last point is contradicting the last point she made. In addition, she acknowledges that there are no studies available that would indicate the safety of 5G. Additionally, *'base stations and sources are thousands of times below required levels' ... 'there is no evidence of the health effects at these levels'*. This is not a correct statement (26).

Discussion

Not only cancer risks, but also other health-related effects, such as fertility, cognitive and neurobehavioral effects, oxidative stress and electrohypersensitivity (EHS) have been associated with RF exposure [for a more detailed discussion please see (5,6,14,27)]. It is thus remarkable that the ICNIRP non-thermal paradigm still is used for evaluation of health risks from RF radiation. One issue for concern is that there seems to be conflicts of interest among individuals in the evaluating groups and that the same individuals may often be found in different bodies thereby citing in fact themselves. This has been outlined in peer-reviewed publications (1,2). Please also see the following website: <https://www.saferemr.com/2018/07/icnirps-exposure-guidelines-for-radio.html>.

In conclusion, herein, the author has demonstrated how the decision-making bodies act and base their decisions on expert statements without their own evaluation of the science. Thereby biased and distorted conclusions find the way into legislation. It is demonstrated that: i) Misinformed and misleading statements are presented by the experts, including 5G is 'nothing new', which is incorrect, as 5G will be deploying beam forwarding technology, significantly wider bandwidths and millimeter waves; that 5G is safe, although however, no evidence is presented in support of this claim, as no such data yet exist; and no health-related effects have been established in the scientific literature, which is a false statement, as a vast scientific body of evidence on RF radiation indicates other-

wise; ii) Many experts providing statements have little or no background in studying the EMF health-related effects; hence; they have no actual expertise on the matter. The majority of the experts that had actual experience in studying EMF health-related effects opposed the 5G roll-out prior to proper safety studies being conducted to ensure its safety for human health.

Herein, the author has revealed a process of political decisions which are misinformed and risk the health of general population, as follows: i) Experts who have no experience in conducting studies on EMF health-related effects are invited into the hearing. These experts provide misleading statements disregarding the vast body of scientific evidence. ii) Officials from government bodies also disregard the vast body of scientific evidence. Hence, government bodies that should protect the health of the population, fail to fulfil their role to inform the decision making body of the risks to human health and well-being. iii) The statements from experts who have experience with studies on EMF-related health effects are disregarded by a number of politicians, ignoring the argumentation and the facts they are presented with.

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Author's contribution

The author LH was responsible for the conception, design and writing of the manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The author declares that there are no competing interests.

References

1. Starkey SJ: Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation. *Rev Environ Health* 31: 493-503, 2016.

2. Hardell L: World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). *Int J Oncol* 51: 405-413, 2017.
3. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol* 12: 624-626, 2011.
4. International Agency for Research on Cancer: Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 102. IARC, Lyon, 2013. <http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf>. Accessed August 21, 2019.
5. Belpomme D, Hardell L, Belyaev I, Burgio E and Carpenter DO: Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environ Pollut* 242 (Pt A): 643-658, 2018.
6. Miller AB, Morgan LL, Udasin I and Davis DL: Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environ Res* 167: 673-683, 2018.
7. NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones. National Toxicology Program, Research Triangle Park, NC, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf. Accessed August 29, 2019.
8. NTP technical report on the toxicology and carcinogenesis studies in Hsd:Sprague Dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. National Toxicology Program, Research Triangle Park, NC, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf. Accessed August 29, 2019.
9. Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, Gnudi F, Mandrioli D, Manservigi M, Manservigi F, Manzoli I, *et al*: Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environ Res* 165: 496-503, 2018.
10. Carlberg M and Hardell L: Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. *BioMed Res Int* 2017: 9218486, 2017.
11. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys* 74: 494-522, 1998.
12. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'. *Health Phys* 97: 257-258, 2009.
13. ICNIRP Note: Critical evaluation of two radiofrequency electromagnetic field animal carcinogenicity studies published in 2019. *Health Phys*: August 27, 2019 (Epub ahead of print).
14. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrlyenko O and Kyrlyenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med* 35: 186-202, 2016.
15. Panagopoulos DJ: Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res* 781: 53-62, 2019.
16. Melnick RL: Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. *Environ Res* 168: 1-6, 2019.
17. Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Shockley KR, Tice RR, *et al*: Evaluation of the genotoxicity of cell phone radio-frequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen*: October 21, 2019 (Epub ahead of print).
18. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R, *et al*: Mobile phone use and brain tumours in the CERENAT case-control study. *Occup Environ Med* 71: 514-522, 2014.
19. Hardell L and Carlberg M: Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radio-frequency radiation at 1,900 MHz. *Int J Oncol* 54: 111-127, 2019.
20. Le Drean Y, Mahamoud YS, Le Page Y, Habauzit D, Le Quement C, Zhadobov M and Sauleau R: State of knowledge on biological effects at 40-60 GHz. *C R Phys* 14: 402-411, 2013.
21. Russell CL: 5G wireless telecommunications expansion: Public health and environmental implications. *Environ Res* 165: 484-495, 2018.
22. Feldman Y, Puzenko A, Ben Ishai P, Caduff A and Agranat AJ: Human skin as arrays of helical antennas in the millimeter and submillimeter wave range. *Phys Rev Lett* 100: 128102, 2008.
23. Betzalel N, Ben Ishai P and Feldman Y: The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? *Environ Res* 163: 208-216, 2018.
24. Soghomonyan D, Trchounian K and Trchounian A: Millimeter waves or extremely high frequency electromagnetic fields in the environment: What are their effects on bacteria? *Appl Microbiol Biotechnol* 100: 4761-4771, 2016.
25. Neufeld E and Kuster N: Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. *Health Phys* 115: 705-711, 2018.
26. Koppel T, Ahonen M, Carlberg M, Hedendahl LK and Hardell L: Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. *Oncol Lett* 18: 5383-5391, 2019.
27. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, Kundi M, Moshhammer H, Lercher P, Müller K, *et al*: EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Rev Environ Health* 31: 363-397, 2016.
28. INTERPHONE Study Group: Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Int J Epidemiol* 39: 675-694, 2010.
29. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. *Pathophysiology* 22: 1-13, 2015.
30. INTERPHONE Study Group: Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Cancer Epidemiol* 35: 453-464, 2011.
31. Hardell L, Carlberg M, Söderqvist F and Mild KH: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. *Int J Oncol* 43: 1036-1044, 2013.



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