Wireless Technologies and the Risk of Adverse Health Effects in Society: A Retrospective Ethical Risk Analysis of Health and Safety Guidelines

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Abstract

Digital wireless technologies increasingly employ radiofrequency non-ionizing radiation (NIR/RFR) for wireless communication. Early wireless technology innovation focused on military, aviation, and telecommunication applications, such as radar and microwave communications. However, the 1980s saw the rollout of commercial consumer-oriented wireless cellular telecommunications systems. While concerns on adverse health effects from exposure to RFR emerged in the military-industrial context in the 1950s, it was not until the early 1990s that there was an institutional response to calls for health and safety protection guidelines. Unfortunately, these guidelines were based on NIR/RFR thermal risks only—the science and technology experts ignored and dismissed a considerable body of research finding adverse health effects from non-thermal exposures. By 2020, that body of research had grown considerably. Yet, for reasons that are unclear to concerned scientists, guidelines from the 1990s remain unchanged. This study conducts a path constitution analysis (PCA) and a retrospective ethical risk analysis (eRA) to help foster an understanding of how historical guidelines were arrived at and why they remain immutable to change. The study finds potentially unethical behaviour in a variety of institutional and organisational actors, the consequence of which is a significant risk to the health and wellbeing of adults and children.

Introduction

Wireless communication technologies enable digital transformation and business model innovation across industries (Hacklin, Björkdahl, and Wallin, 2018). The digital technology and telecommunications sectors are mainly dependent on the use of wireless systems and devices to enable their business models, while transport, medical, entertainment, retail sectors, finance, and so on, also depend heavily on these technologies to innovate, underpin business value propositions, and to deliver services. Consequently, domestic homes are increasingly digitized through a range of wireless communication technologies in smart devices from home security, to heating, to domestic appliances, and of course devices smartphones, tablets, and wearable and other personal devices, leading to the 'digitisation of individuals' (Turel et al., 2020). WiFi routers have become the beating heart of the digital home and workplace, connecting as they do all end-user wireless devices to the Internet (Wenbo, Quanyu, and Zhenwei, 2015). 5G technologies are posited to underpin next-generation business model innovation (Yrjola, 2020).

Until the advent of 5G wireless technologies and the public controversy surrounding them, most people paid little attention to what was widely reported in science and technology studies (STS)—wireless technologies carried known risks to human health and well-being from non-ionizing radiation (NIR), which is being emitted from such devices. The considerable increase in human and environmental exposures to NIR from all sources is generally unrecognised despite its significance (Bandara and Carpenter, 2018).

What are the findings of peer-reviewed scientific studies on the health effects of radiofrequency non-ionizing radiation and the implications for human health and wellbeing?

Most peer-reviewed scientific studies on radiofrequency non-ionizing radiation[1] (RFR) conclude that human health and wellbeing may be under significant threat from wireless technologies. These studies

[1] Radiofrequency radiation (RFR) is a type of non-ionizing radiation (NIR), which is also referred to as radiofrequency (RF) electromagnetic fields (EMFs). In keeping with relevant research papers, this paper employs the term RFR, as opposed to RF EMF or simply EMF, which includes very low frequency radiations from power lines, RF EMFs are in the frequency range 100 KHz to 300 GHz, this includes all 2-5G, 2.4-5G WiFi and Bluetooth technologies. In Europe, 5G technologies will emit

focus on RFR exposures from existing 2G, 3G, 4G systems, WiFi, and Bluetooth. However, 5G technologies are novel and unresearched, although extant research on adverse health effects from previous generations provides a factual basis for assessing risk (Frank, 2021). 2-4G technologies will continue to be used together with 5G systems for the foreseeable future. The evidence from extant scientific research and the nascent body of research on 5G strongly suggests that 5G is likely to increase and, in some cases, magnify the risks of existing wireless technologies (Di Ciaula, 2018; Miligi, 2019; Russell, 2018; Kostoff et al., 2020; Barnes and Greenebaum, 2020).

Early Warnings but no Late Lessons

In the late 1960s, the cumulative body of early scientific literature on the adverse health effects from RFR exposures from radar and nascent microwave communications systems was documented by the U.S. navy (Dodge, 1969). The comprehensive review of research published by the U.S. Naval Medical Research Institute (NMRI) between 1969-1976 generated an extensive bibliography of over 3,700 studies, which demonstrated that wireless technologies and other RFR sources had harmful thermal (direct and indirect) and non-thermal adverse health effects, which include cancers, neurological, neurodegenerative, and other pathophysiological problems (Glaser, 1971, 1972; Glaser et al., 1976).

Since 1976, thousands of independent research studies—*in vitro*, *in vivo*, and epidemiological—have confirmed that RFR is associated with or contributes to a range of adverse health effects, including pathophysiological effects, in experimental animals and humans. In one of the first comprehensive independent reviews since 1976[2], the monograph titled the *Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter* (Giuliani and Soffriti, 2010) reports on the biological mechanisms, cellular mechanisms, and tissue effects of both EMFs and RFR. It also presented a summary of the state of extant *in vivo* and epidemiological research to 2010. From a public health perspective, one of the most alarming findings is the reported carcinogenicity of RFR exposures: Although, earlier reviews had indicated this as probable (Goldsmith, 1997). From an epidemiological perspective, the cancer risk of exposure to environmental toxins is challenging to ascertain. There are several reasons for this: One of the principal explanations is that it typically takes between 20 or 30 years for many types of cancers to develop following exposure to a carcinogen, and epidemiological data to reflect this and enable risk assessment. Besides, it must be noted that well-designed studies *"require populations that are followed for at least 20 years, preferably 30 or more"* (Michaels, 2008, p. 82). However, practically all independent scientists agreed that by 2010, there was sufficient evidence of cancer risk from RFR exposures and for society to implement the precautionary principle (cf. Giuliani and Soffriti, 2010; Stein, Levy-Nativ, and Richter, 2011; Hardell, Carlberg, and Gee, 2013; Hardell and Carlberg, 2021)

Is RFR a Carcinogen?

In 2011, the World Health Organisation (WHO) International Agency for Research on Cancer (IARC) classified radiofrequency RFR as a ***possible*** Group 2B carcinogen. While the findings of epidemiological studies have been debated, and chiefly focus on the long-term development of brain tumours, a recent review of such studies is unequivocal and states that *"[m]obile phone radiation causes brain tumors and should be classified as a **probable** human carcinogen (2A)"* by the WHO's IARC (Morgan et al., 2015). A majority of scientists conclude that it should be reclassified, with strong arguments being put forward from various scientists for RFR to be a Group 1 human carcinogen (Miller et al., 2018).

The cause-effect relationship between RFR and cancers in animals is demonstrated in the finding of *"clear evidence"* of carcinogenicity in animals due to RFR exposure in the US National Toxicology

RFR (RF EMF) in the frequency 700 MHz-28GHz, and beyond. Currently three frequency bands are in operation: low frequency (700MHz), high frequency (3.4-3.8 GHz, centimetre (CM)) or extremely high-frequency millimeter (MM) (26 GHz and above) RFR.

[2] Reviews have also been conducted by committees from the IEEE (1991, 2005, 2019), ICNIRP (1998, 2020), SCENIHR (2015): However, as is argued in this paper, these are ethically and methodologically questionable in terms of their assessment of risk due to alleged conflicts of interest involving industry.

Program (NTP, 2018a,b) and Ramazzini Institute studies (Falcioni et al., 2018). Following the release of the NTP peer-review study, Belpomme et al. (2018) pointed out that *"[t]he classification of RF-EMFs as a "possible" human carcinogen was based primarily on evidence that long-term users of mobile phones held to the head resulted in an elevated risk of developing brain cancer. One major reason that the rating was not at "probable" or "known" was the lack of clear evidence from animal studies for exposure leading to cancer."* Given this, one could assume that the findings of the NTP studies mean that this obstacle to RFR reclassification as a probable or known Group 1 carcinogen is only a matter of time. However, Dr. Ron Melnick, former Senior Toxicologist and Director of Special Programs in the Environmental Toxicology Program at the National Institute of Environmental Health Sciences (NIEHS), points out that *"[t]o classify an agent as 'carcinogenic to humans" (group 1), IARC requires 'sufficient evidence' in humans of a causal relationship between exposure to the agent and human cancer.."*[3] Dr. Melnick is unequivocal in arguing for the strength of the relationship, as is, former ICNIRP commissioner Professor James Lin (2019, p. 19), who concluded that: *"The time is right for the IARC to upgrade its previous epidemiology based classification of RF exposure to higher levels in terms of the carcinogenicity of RF radiation for humans."* This is clear and unambiguous as the findings of both the NTP and Ramazzini Institute studies that provided *"clear evidence,"* the highest burden of scientific proof possible concerning the carcinogenicity of RFR (Melnick, 2019).

Thus, the IARC Monographs Priorities Group (2019) publication specifically points to the NTP (2018a,b) and Ramazzini Institute studies (Falcioni et al., 2018) to highlight advances in animal studies. The Group cites research by Kocaman et al. (2018), which concludes that: *"Results from in vitro and in vivo studies represent strong evidence of a carcinogenic effect of RF, but epidemiological studies have not yet confirmed this."* Nevertheless, scientists from the IARC Monograph Priority Group did find studies by Coureau et al. (2014), Carlberg & Hardell (2015), and Pedersen et al. (2017) compelling. As indicated, the long latency in the development of such tumours and exposure periods means that further epidemiological studies are required to inform appropriate risk assessments. Nevertheless, the IARC Monograph Priority Group concluded in its ***"Recommendation for non-ionizing radiation (radiofrequency): High priority":*** This is a clear signal to policymakers of the need to reassess the risk to public health.

The author created a bibliography of epidemiological research and reviews on cancers in humans since the IARC (2011) using data from personal communications with scientists who peer-reviewed his risk assessment monograph in 2020. This review lists 60 studies, 57 of which did not inform the deliberations of IARC Monograph Priority Group or recent assessments by the FDA. These peer-reviewed studies document the incidence and risk of the following cancers: Brain tumours; Tumours of the Meninges (Meningioma); Hearing Nerve Tumour (vestibular Schwannoma; acoustic neuroma); Parotid Gland Cancer; Eye Cancer; Cancers of the Breast (male and female); Melanoma of the Skin; Leukaemia; Thyroid Cancer (male and female); and Colorectal Cancers. The author acknowledges that the studies vary in terms of their perceived strength and in how they provide evidence of the association between RFR and cancer endpoints: Nevertheless, together, they offer a convincing body of experimental and epidemiological evidence that taken in the round provide the weight of evidence (WOE) (cf. Krimsky, 2005; Martin et al., 2018) required to invoke the precautionary principle (see also BioInitiative Working Group, 2012; Belpomme et al., 2018; Miller et al., 2019; Pall, 2018; Frank, 2021).

Research demonstrates that *"[p]ublic health authorities in many jurisdictions have not yet incorporated the latest science"* (Miller et al., 2019) and therefore stand accused of failing to perform adequate risk assessments of RFR emitting technologies (Melnick, 2020; Hardell and Carlberg, 2020). Research on the RFR-cancer association indicates, the human central nervous system (CNS) is at particular risk from RFR exposures: Adverse biological effects identified in the scientific literature confirms this and identifies altered neurotransmitter function, cellular signalling problems, blood-brain barrier breakdown, neurological and neurodegenerative disease, and electrohypersensitivity (EHS)—also

[3] Personal communication with the Dr. Ron Melnick, a former Senior Toxicologist and Director of Special Programs in the Environmental Toxicology Program at the National Institute of Environmental Health Sciences (NIEHS) in response to the original draft of the author's 144 page ethical risk assessment monograph.

identified are associations with impairment of human reproduction systems, apoptosis, and cellular DNA damage, leading to cancer (see Belpomme et al., 2015, 2018; Miller et al., 2019; Johansson, 2015; Pall, 2018). However, the causal association with cellular oxidative stress is perhaps the most important finding and risk factor due to its involvement in most, if not all, of the previous adverse health effect endpoints. Also of note is that these risks occur at much lower RFR power density levels than those that the current thermal safety guidelines permit (see exposure levels cited above and in comprehensive reviews of extant research by Belyaev et al., 2016, and the BioInitiative Working Group, 2012-2020).

Clear Evidence that RFR is Associated with Oxidative Stress

Research on RFR, particularly polarized, pulsed microwave signals in mobile phone and WiFi sources, demonstrated that they produce elevated levels of reactive oxygen species (ROS), which in turn cause oxidative stress in cells (De Iuliis et al., 2009; Georgiou, 2010; Nazıroğlu, et al., 2013; Yakymenko et al., 2016; Golomb, 2018). Oxidative stress is caused by an imbalance between ROS and the counter effects of antioxidants that help detoxify and repair biological systems. Thus, the body normally employs antioxidant defence mechanisms to counter ROS and help avoid diseases such as cancer, which are triggered by oxidative stress and its tendency to cause strand breaks in cellular DNA. A raft of studies indicates that a chain of biological mechanisms produces oxidative stress and reports on observed negative health outcomes in laboratory animals and adverse health effects in humans (Pall, 2018: cf. Barnes and Greenebaum, 2016).

In identifying the mechanisms that produced biological effects from RFR exposure in her study of US American diplomats in Cuba, Professor Beatrice Golomb (2018) states that *"Oxidative stress provides a documented mechanism of [RFR] injury compatible with reported signs and symptoms; sequelae of endothelial dysfunction (yielding blood flow compromise), membrane damage, blood brain barrier disruption, mitochondrial injury, apoptosis, and autoimmune triggering afford downstream mechanisms, of varying persistence, that merit investigation."* Dr. Golomb (ibid.) elaborates further: *"Oxidative stress refers to a kind of injury against which "antioxidants" relatively protect, in which "reactive oxygen species" or "free radicals" produce changes/damage that can affect, for instance, lipids, proteins, DNA, and RNA. Mitochondria, which are the primary source of energy for cells (and regulate many other phenomena such as steroid hormone production and apoptosis) are a leading source and target of oxidative stress… – that is, mitochondrial injury not infrequently accompanies oxidative stress, and has been shown with [RFR] …[RFR] produces oxidative stress…in an analysis of 100 studies examining if low-level [RFR] produced oxidative injury, it was reported that ~93 found that it did. Oxidative stress – and mitochondrial dysfunction are implicated in the symptoms and health effects that have been reported by diplomats (and RF/MW affected persons)."*

Golomb (2018) reflects the views of most scientists when she concludes that oxidative stress plays a role in producing adverse health effects from RFR exposures (cf. Yakymenko et al., 2016; Mevissen, and Schürmann, 2021). She points out that electrosensitive people are more than likely to possess gene variants that offer less protection to oxidative injury (De Luca et al., 2014). Second, EHS sufferers have been identified as possessing low levels of melatonin. This antioxidant protects against damage by toxins, and many studies demonstrate that melatonin protects against oxidation injury from RFR. These two facts to *"compellingly support a role for oxidative stress – and to show that that those with ES – those who experience symptoms with radiation that others tolerate – are also experiencing greater cellular and subcellular injury from this radiation"* (Golomb, 2018).

Thus, there is almost unanimous agreement that the property of RFR to place human cells into oxidative stress lies at the core of almost all health risks, as indicated above (Yakymenko et al., 2016; Mevissen, and Schürmann, 2021). The generation of reactive oxygen species (ROS) is central. Recent studies of people living in proximity to mobile base stations found evidence for elevated levels of ROS in their blood, which is a biochemical indicator of oxidative stress, indicating that they are exposed to greater risks of ill-health (Zothansiama et al., 2017). The CNS appears to be the most vulnerable human biological system affected here, with neurodegenerative diseases, neurobehavioral (including problems with learning and development in children), immunological problems, and the range of symptoms and functional impairments associated with electrohypersensitivity, the source of concern to scientists (Barnes and Greenebaum, 2020; Belpomme et al. 2018; Belyaev et al. 2016; Di Ciaula, 2018; Golomb,

2018; Miller et al., 2018; Russell, 2018, among many others). Rigorous experimental studies on laboratory rats have found that daily exposures to low levels of microwave radiation, such as that emitted by WiFi devices, similar to those being introduced in wireless 5G systems, causes significant biological changes in a range of major organs such as the brains, hearts, reproductive systems, and eyes of the rats being studied (Chauhan et al., 2017; Wilke, 2018). Scientists and medical practitioners are concerned about the significant risks placed on the most vulnerable in society, examples including children, pregnant women, those with existing health issues, and senior citizens: Over 400 concerned scientists signed an appeal to this effect in 2020 (5G Appeal, 2020).

Is there a Weight of Evidence in relation to RFR Risks?

As of June 2020, Aachen University's EMF Portal catalogues 31,329 publications and 6,734 summaries of individual scientific studies on electromagnetic fields (EMFs), with an estimated 1,892 studies on RFR. A more comprehensive database on RFR is that curated by Oceania Radiofrequency Scientific Advisory Association Inc. (ORSAA): Its database catalogues 3,671 studies on the relationship between RFR exposure and adverse health effects.[4] It is an interesting fact that independent scientific studies are two and a half times more likely to find evidence of biological effects and health risks than industry-funded studies (Huss et al., 2006; Prasad et al., 2018; Leach et al., 2018). It is also generally agreed that independent studies have greater scientific validity and are better executed (Michaels, 2008, 2020)—due, perhaps, to the absence of conflicts of interest. Dr. Henry Lai, Professor Emeritus at the University of Washington, reports that in studies conducted between 1990 and 2017, evidence of adverse health effects were found in the majority viz. DNA damage (64%), neurological effects (72%), and oxidative stress (90%).[5] A recent analysis of thousands of scientific studies on the biological effects of RFR in the ORSAA database found the following: *"There are 3 times more biological "Effect" than "No Effect" papers; nearly a third of papers provide no funding statement; industry-funded studies more often than not find "No Effect", while institutional funding commonly reveal "Effects*"" (Leach et al., 2018). These percentages of effects and risks represent the weight of evidence and are as follows: 68% of peer-reviewed scientific research studies found physical and biological non-thermal effects, while only 32% of studies, found no evidence of effects (Leach et al., 2018). In a separate study, Bandara and Weller (2017) found evidence of oxidative stress effects in 89% of papers in the ORSAA database. Thus, research cited therein indicates that the weight of objective scientific evidence has consistently found significant risks to human health—these risks are magnified where children are concerned.

Unfortunately, practically all policymakers and regulators appear not to understand the difference between the type and strength of scientific evidence required to demonstrate strong associations or causality between normal RFR exposures adverse health effects: They are therefore at the mercy of inadequate, flawed, and misleading risk assessments by captured agencies (Alster, 2015; Adlkofer, 2015; Buchner and Rivasi, 2020); consequently, they are unable to adopt timely, precautionary approach to reducing risks to human health and wellbeing (cf. Gee, 2008, 2013; Hardell, Carlberg, and Gee, 2013; Grandjean, 2013).

A question therefore begs as to whether, given the weight of evidence, those charged with protecting public health have acted ethically and responsibly in minimising societal risk? In order to help answer this question, the following section presents a theory-based analytical lens.

Wireless Technology Risk and Business Ethics: Analytical Lens

The first concept that requires attention is that of risk. As Hansson (2009, 2013, 2018) points out, the concept of risk has several legitimate meanings: It has a qualitative everyday meaning and a quantitative formal or scientific meaning. Risk denotes both the cause of expected and unexpected, desired and undesirable, outcomes expressed in terms of their danger or severity. In a scientific, engineering, or actuarial view, risk is expressed quantitively as probabilities. In applied contexts, across disciplines focusing on social, political, security, and environmental matters, risk is conceptualised in terms of threats (hazards), vulnerabilities, and impact (consequences/expected and unexpected outcomes/losses

[4] Oceania Radiofrequency Scientific Advisory Association Inc. / https://www.orsaa.org/

[5] https://bioinitiative.org/research-summaries/

(Brauch, 2005): However, as Cox (2008) argues, due to uncertainty and other factors, this approach to risk assessment may be unsuited to specific risk scenarios.

Qualitative conceptions of risk reflect a lack of knowledge, which introduces the concept of uncertainty, as the incidence (frequency) and probability of causes and outcomes are typically unknown. Hansson (2009, p. 14: cf. 2018) points out that ethical issues arise when quantitative assessments of risk are not possible:

> *"The ethical problems of risk often concern factors that are not covered by probabilities or expectation values. Therefore, the ethics of risk takes 'risk' in the wide, everyday sense of the word as its subject-matter. The ethics of risk is not limited to any of the more technical senses in which the word 'risk' is used. To avoid misunderstandings about this, we can use the longer phrase 'ethics of risk and uncertainty'. 'Uncertainty' is the common decision-theoretical term for nonprobabilizable lack of knowledge…"*

In the context of this study, the concept of the value dependence of risk assessments is also apposite. In 1983 the American National Academy of Sciences proposed risk assessment and risk management as two separate activities in a dichotomous model. The first is a scientific endeavour that characterises the nature and magnitude of risk, while the second *"combines* [this] *with economic and technological information pertaining to various ways of reducing or eliminating the risk in question, and also with political and social information. Based on this, a decision is made on what measures – if any – should be taken to reduce the risk"* (Hansson, 2009, p. 15). However, in the International Commission on Radiological Protection (ICRP), the associated International Commission on Non-ionizing Radiation Protection (ICNIRP), and other NGOs and agencies charged with protecting public health, members same committees are responsible for developing both risk assessments and risk management guidelines and standards. The ICNIRP is particularly problematic here as its members act on bodies that review its protection guidelines' validity: This is ethically questionable, as risk assessment and management decision-making processes are not value-free—they are "infused with value". (In the context of the current study, wireless technologies are also value-laden and organic, in the sense that they evolved outside the control of society (Martin and Freeman, 2004)). Thus, Hansson (ibid.) argues that: *"Exposure limits and other regulations are often presented as 'scientific' and 'value-free' in spite of containing obviously value-based judgements on what risks to accept … However, it is important for the quality of risk decision processes that the hidden value assumptions in risk assessments are uncovered."* The health and safety guidelines and standards that non-government organisations (NGOs—e.g. the ICNIRP), industry standards bodies (e.g., the Institute of Electrical and Electronics Engineers (IEEE) and its International Committee on Electromagnetic Safety (ICES)), and others, instituted in the past to protect public health are argued to be based on independent science-based, historical risk assessments (Osepchuk & Petersen, 2003): cf. Hansson, 2009, 2018). However, it is now acknowledged that a range of normative (values—professional and political) and cultural-cognitive influences (e.g. heuristics, bias and motivated reasoning) operate to shape risk assessment and management outcomes (cf. Clarke, 1988; Freudenburg, 1992; Glendon et al., 2016; Hahn and Harris, 2014; Curley et al., 2020).

Collectively referred to as institutional logics, dominant (and competing subservient) logics develop over time and inform decision making in organisations and institutions. Thornton and Ocasio (1999, p. 804) define institutional logics as *"the socially constructed, historical patterns of material practices, assumptions, values, beliefs and rules by which individuals produce and reproduce their material subsistence, organize time and space and provide meaning to their social reality."* Clearly, institutional logics will suffer from the negative influence of heuristics, bias and motivated cognition and reasoning (Bardon, 2019). Interestingly, the influence of logics over time and space brings into play the concepts of path dependence and creation, which we now discuss.

Path Constitution Analysis

Path Constitution Analysis (PCA) is an approach for understanding path dependence and path creation in institutions and organisations (Sydow et al., 2012). *Path dependence* arises when initial social, economic, legal, or technical conditions and historical antecedents influence future outcomes for organisations and institutions (Mahony, 2000). According to David (2007, p. 92): *"'Path dependence''*

is an important concept for social scientists engaged in studying processes of change, as it is for students of dynamical phenomena in nature. A dynamical process whose evolution is governed by its own history is ''path dependent.'' The concept, thus, is very general in its scope, referring equally to developmental sequences (whether in evolutionary biology or physics) and social dynamics (involving social interactions among economic or political agents) that are characterized by positive feedbacks and self-reinforcing dynamics." Path creation reflects the fact that actors, and/or communities of actors, may have similar desires and beliefs and act to achieve mutually compatible objectives and outcomes.

PCA provides a lens to analyse transformational change and/or maintenance of the status quo in institutional environments by studying the path or paths in time-space. According to Sydow et al. (2012, p. 159) a *path* is

> *"a course of events interrelated on different levels of analysis, such as a single organization or an organizational or technological field, and in which one of the available technological, institutional or organizational options gains momentum in time-space, but cannot automatically be determined from the onset. This non-ergodic development is triggered by certain actions or events, and driven by specific self-reinforcing mechanisms that not only cause the momentum, but might lead the whole process into a lock-in that is, at least from a strategic perspective, inefficient."*

Thus, a PCA attends to *"(a) level interrelatedness, (b) triggering events, (c) non-ergodic processes, (d) self-reinforcing processes, (e) lock-in, and (f) multiple actors who intentionally or unintentionally (re) produce the path in time-space"* (ibid.). These conceptual elements will be further elaborated in their application in the case study of ethical risk assessment and management of wireless technologies.

The risks to society from the widespread use of wireless technologies are related to interrelated historical risk assessment and management decisions by a range of social actors at different points in time. These actors—scientists, technologists, and engineers—populate(d) key institutions such as government agencies (FCC, FDA and national counterparts in other nations), the World Health Organisation, the ICNIRP NGO, whose decisions are (or were) informed by historically immutable and shared dominant logics that reflect the norms and cultural-cognitive influences shaping ethical risk decisions. Thus, while a PCA enables a path to be assessed across time-space, an ethical risk analysis (eRA) is required to understand events at specific junctures of path creation.

Ethical Risk Analysis (eRA)

As indicated above, *"traditional risk analysis…puts emphasis on the probabilities and severities of undesirable events but does not cover ethical issues such as agency, interpersonal relationships, and justice"* (Hansson, 2018, p. 1820). Research cited herein also reports that risk analysis and management decisions are subject to the influence of norms, values, cognitive bias, and other institutional logics. Hansson (2018) argues that an ethical risk analysis (eRA) should be employed to supplement traditional risk analyses and risk management decisions. This involves the application of a three-step method:

1. Three different categories of people need to be identified: (i) those in society exposed to risk; (ii) those who benefit from society accepting the risk; and (iii) Those who make the decisions regarding the identification, assessment, control, and mitigation of the risk.
2. These three different types of roles and role combinations are then analysed to identify *"ethically problematic role combinations".* As Hansson (2018, p. 1822) argues, *"[d]istinguishing between these different roles makes it easier to accurately describe the pertinent differences in powers, interests, and vulnerabilities, which is necessary for an ethical analysis."*
3. The following analyses are then performed: (i) An individual risk-benefit weighing; (2) a distributional analysis; (iii) a rights analysis; and (iv) a power analysis. In addition, the roles of experts and journalists are assessed.

While this framework is prospective and normative, relevant elements may also be used as an analytical lens in a retrospective ethical analysis of institutional risk assessment and management guidelines that

inform public polices, such as those focusing on potential biological and adverse health effects of RFR exposures.

Applying the Analytical Lens to Evaluate Historical RFR Risk Assessments

Governments and policymakers across the globe reference the risk assessments of RFR exposures in occupational and public spheres in the guidelines provided by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Thus, across the globe, public health bodies and policymakers accept unquestioningly the risk assessment found in ICNIRP Guidelines (ICNIRP, 1998, 2020) and reject the existence of adverse health effects from non-thermal exposures to RFR (Starkey, 2016; Pockett, 2019; Buchner and Rivasi, 2020). The ICNIRP Guidelines (1998) and the U.S. Federal Communications Commission (FCC) regulatory provisions[6] provide the dominant institutional logics for regulators and agencies globally concerning risk management of public health. These logics hold that RFR exposures impose adverse health effects at the thermal threshold where human tissue is heated. They do not admit the existence of non-thermal adverse health effects. Hence, they conclude that given appropriate exposure guidelines, which specify set thresholds, there is no risk to human health and well-being—this is the dominant institutional logic (cf. Cherry, 2000, 2004; Hardell and Carlsberg, 2020).

RFR Institutional and Scientific Logics underpinning Path Genesis and Creation

The origin of the institutional and scientific logics that dominate the technology industry and related regulatory agencies emanates from the theoretical work a German scientist, Dr. Herman P. Schwan. Dr. Schwan was recruited by the U.S. Department of Defense along with other German scientists, many of them Nazis and guilty of war crimes, as part of Operation Paperclip (Jacobsen, 2014). Thus, Dr. Schwan was employed by the U.S. Naval Medical Research Institute (NMRI) in 1947, following initial contact with the NMRI at the war's end (Foster, 2002). Dr. Schwan's research for the U.S. military-industrial complex focused on the effects of EMF (including RFR) on biological systems. He joined the University of Pennsylvania in 1950 and continued his research there, subsequently as part of the Tri-service Program (Michaelson, 1971). *"As a result of these interests, and from committee work with government agencies (initially the U.S. Navy), Schwan became a dominant figure in the recurring debates about biological effects of electromagnetic fields"* (Foster, 2002, p. 17). In 1953, Schwan proposed *"a safe limit for human exposure to microwave energy of 100 W/m^2* [10 mW/cm^2] *(based on thermal analysis), [which] became the basis for exposure standards in the United States and elsewhere. These standards have evolved over the years (in particular, they acquired a frequency dependence that reflects that of the absorption cross section of the human body) <u>but without fundamentally changing their scientific basis</u>[7]. Among many other committee activities in this field, he chaired the committee that established the first (1965) United States exposure limit for RF energy, for the American National Standards Institute"* (ANSI) (Foster, 2002, p. 20). Schwan's position saw his theories became the dominant logics for industry standards bodies such as the Institute of Electrical and Electronics Engineers (IEEE) and ANSI (cf. Michaelson, 1971; Schwan, 1971; Osepchuk and Petersen, 2003). Eminent physicist Robert Adair (2003, p. 39) provide legitimacy for this and states that weak field RFR is *"unlikely to affect physiology significantly through athermal mechanisms. Biological systems are fundamentally noisy on the molecular scale as a consequence of thermal agitation and are noisy macroscopically as a consequence of physiological functions and animal behavior. If electromagnetic fields are to significantly affect physiology, their direct physical effect must be greater than that from the ubiquitous endogenous noise"*: However, the results of countless studies falsify this theory as the reviews cited

[6] The FCC "adopted the specific absorption rate (SAR) limits for devices operating within close proximity to the body as specified within the ANSI/IEEE C95.1-1991 guidelines. (See Report and Order, FCC 96-326) The Commission's requirements are detailed in Parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093" Source: https://www.fcc.gov/general/radio-frequency-safety-0.

[7] Emphasis added. Dr. Kenneth Foster is an ardent disciple of Dr. Schwan and is as influential in resisting any change to the "scientific basis" of the thermal only scientific logic, which is based on a flawed and outdated conception of physics (see Adair, 2003 versus Barnes and Greenebaum, 2016; Panagopoulos, 2018).

herein indicate (Cf. Pall, 2018), while competing theories provide evidence of mechanisms (see Barnes and Greenebaum, 2016; Panagopoulos, 2018).

As a picture paints a thousand words: Figure 1 from Foster (2002, p. 20) illustrates how Schwan (in 1963) and his followers to this day determine safe exposure limits to RFR: However, computer-based simulation is increasingly employed. Others in the U.S. Army, Air Force, and Navy Tri-service Program used horrific animal experiments, reminiscent of those performed by Nazis on animals and humans, to support Schwan's thesis that 10 mW/cm^2 standard was safe (Michaelson, 1971, p.131). Animal experiments aside, Schwan's approach is useful for estimating thermal effects only and is wholly inappropriate to assess non-thermal biological effects. In summary, the thermal-only safety levels for RFR in the US and Europe were determined by the US military-industrial complex viz. *"the military dominated the scientific discussion on safety limits and science, already aware of the possible health hazards at that time, fell by the wayside. In agreement with the U.S. Government, the U.S. Armed Forces – supported by the microwave industry – established safety limits according to military requirements without taking much care of possible health concerns. At the same time they shielded the Government, which was not ready to openly take over the responsibility for this development, since it was afraid of negative consequences from the public opinion"* (Adlkofer, 2015: cf. Cook et al. 1980; Becker and Selden, 1985).

Figure 1 "Schwan with model of human body used for RF dosimetric studies. The model is filled with tissue-equivalent liquids and exposed to RF energy in a microwaveanechoic chamber that Schwan had constructed in his laboratory."(Foster, 2002, p. 20)

On the other side of the Iron Curtain during the 1950s and 1960s, Soviet and Eastern Bloc scientists were asking different research questions based on holistic assumptions about the biological effects of RFR. They recognised the existence of non-thermal adverse health effects: Consequently, their scientific research answered questions to inform risk assessments and management on all RFR hazards on one hand, and the application of RFR for military and intelligence use on the other. It is more than coincidental that between 1971-1976 the U.S. Naval Medical Research Institute's Dr. Zory Glaser and his team catalogued and analysed the significant biological and adverse health effects of RFR—both

thermal and non-thermal. These were then identified and accepted by Soviet and Eastern-Bloc scientists. In its final report in 1976, the NMRI documented 3,700 scientific papers on the thermal and non-thermal biological and adverse health effects of RFR (Glaser et al. 1976).[8] In summary, the NMRI identified the following findings:

- Thermal effects identified include heating of the whole body, brain, eyes, testicles, and sinuses, among others.
- Non-thermal effects identified include oxidative process change (a precursor for many of the adverse health effects, including DNA strand breaks and ultimately cancer), decreased fertility, altered foetal development, muscle contraction, cardiovascular changes, altered menstrual activity, liver enlargement, changes in conditioned reflexes, and so on.

Contemporaneously, the US Office of Telecommunications Policy began its *Program for control of electromagnetic pollution of the environment: the assessment of biological hazards of nonionizing electromagnetic radiation* in 1970 (Healer, 1970). Four reports were issued during the 1970s until government reorganization in 1978 saw the Department of Commerce and the National Telecommunications and Information Administration replace the Office of Telecommunications Policy. The *"NTIA is the Executive Branch agency that is principally responsible for advising the President on telecommunications and information policy issues."* The fifth and final report of the Program was published in 1979: this body of work built on that by the NMRI and voiced concern on the health implications of human exposure to RFR. It concluded on the need for a comprehensive research programme to protect public health, with the EPA to continue its program of research on biological effects (NITA, 1979).

In 1981, the pro-business Reagan Administration *"launched an overt attack on the EPA, combining deregulation with budget and staff cuts"* (Fredrickson et al. 2018). Hence, the *"trend toward stricter controls on activities perceived as harmful to public health"* (David, 1980) either plateaued or went into reverse during the 1980s. Certainly, the *Program for control of electromagnetic pollution of the environment* appears to have been set aside: This program, like the EPA and the *Clean Air Act*, was instituted by the Nixon Administration. Both the *Clean Air Act* and the EPA have been targeted by politicians on both sides of the political aisle because of industry lobbying and influence (Alster, 2015).

Despite the evidence presented by Dr. Glaser and NITA, under the influence of dominant logics, many U.S. scientists held that there were only thermal RFR exposure-related adverse health effects. This was due in no small way to the influence of Dr. Schwan's dominant logics, which also provided the army, air force, navy, and their defence technology firms, with a justification to maintain the status quo and lobby politicians accordingly. Thus, valuable opportunities were lost to research and develop safer wireless technologies and more apposite standards during the 1970s and 1980s (See Kane, 2001).

The Philosophical and Political Nature of Institutional and Scientific Logics

In an extensive report in 1980, this is described as a philosophical difference based, perhaps, on cold-war politics (David, 1980).

> *"To a large degree, discrepancies between Eastern and Western microwave standards are due to contrasting philosophies. For the U.S. the concept of risk/benefit criterion has been accepted, involving use of an adequate safety margin below a known threshold of hazard. On the other hand, Soviet and most East European microwave standards are based on a "no effect" philosophy-all deviations from normal are hazardous. Yet to be determined, however, are definitions of what connotes a "hazard" or "adequate" safety margin in terms of microwave exposure.*
>
> *Historically, for the U.S., development of radar technology used in World War II led to reports of bioeffects among military personnel, with' studies ordered to analyze the impact of microwave radiation on the human. A 10mW/cm2 level, as a microwave protection guide, was initially proposed in 1953 by a biophysicist, Dr. Herman Schwan. This value was established*

[8] https://ehtrust.org/wp-content/uploads/Naval-MRI-Glaser-Report-1976.pdf

from theoretical calculations on the amount of exogenous thermal loading that can be tolerated and dissipated by the body without a harmful rise in body temperature… there is dispute regarding the possibility that radiowave and microwave radiation may have subtle but deleterious effects at power levels below that which cause gross heating of biological tissues. The controversy is fueled by experimental and clinical findings in the Soviet Union, Eastern European countries, and, most recently, the United States, which indicate that various organisms, including the human, are possibly sensitive to low-level (presumably non-thermal) radiation. Thus far, it has been difficult to find agreement among investigators on the chronic effects of exposure to low-level microwave radiation below which no damage will occur."

The findings and points made by Dr. Leonard David in 1980 echo down the decades, as the paradigm war on RFR was not as easily resolved as the Cold War, and any change to the dominant logic proved difficult, if not impossible, to negotiate. These logics still pervades key standards-setting and risk assessment bodies which Schwan influenced, such as ANSI and IEEE—The very bodies that the FCC, FDA, ICNIRP, and regulatory bodies globally look to draft health and safety regulations.

The Institution of the ICNIRP to Maintain the Dominant Institutional and Scientific Logics

In 1990, a comprehensive peer-reviewed study by the EPA concluded that there is reason to believe that "*the findings of carcinogenicity in humans are biologically plausible,"* with EMFs as *"a possible, but not proven, cause of cancer in humans"* (McGaughy et al., 1990). From 1975 to 1995, the EPA researched the health effects of RFR and was about to develop EMF safety standards, before it was de-funded. The IEEE is the predominant industry standard setting body for the electrical and technology industries and telecommunications. In 1991 the IEEE released the C95.-1991 (which Revision of ANSI Std C95.1-1982) standard covering *"safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz."* This standard rubberstamped the industry position that the human health and safety was not at risk: Interestingly, Dr. Hermann Schwan was a member of the IEEE committee. This standard helped negate the EPA's argument that there was cause for concern. Alster (2015) cites Carl Blackman, a scientist at the EPA until retiring in 2014, as being *"cautious in imputing motives to the high government officials who wanted his work at EPA stopped. But he does say that political pressure has been a factor at both the EPA and FCC: ―The FCC people were quite responsive to the biological point of view. But there are also pressures on the FCC from industry. The FCC, he suggests, may not just be looking at the scientific evidence. ―The FCC's position—like the EPA's—is influenced by political considerations as well."* Thus, the industry effectively neutralised the one independent body in the US performing comprehensive research in the area while also "capturing" the FCC (Alster, 2015). While influence over the FCC and FDA to help maintain the dominant institutional and scientific logics in the US was vital, wireless technologies were being introduced on a global scale: Hence the telecommunications industry had to find similar mechanisms as those in the U.S. to convince policymakers and the public that these technologies were safe.

At the General Assembly of the International Radiation Protection Association (IRPA) on May 29, 1992, held in Montreal, IRPA members created the ICNIRP for the purpose of protecting public health from NIR. The ICNIRP was charged with employing the same fundamental principles and approaches as IRPA. It is significant that through the agency of its champion within the IRPA and its first Chair, Michael Repacholi, the ICNIRP had the support of the WHO from the outset. It also had the support of the telecommunications and electrical industries, and particularly the IEEE. The ICNIRP was based in the German Radiation Protection Agency (Bundesamt für Strahlenschutz) building in Munich, Germany.

Evidence shows that the ICNIRP has, since its inception, systematically rejected independent scientific evidence demonstrating adverse health effects from RFR (Cherry, 2000, 2004; Hardell, 2019; Hardell and Carlberg, 2020). The ICNIRP's founder and first chair carefully selected commission members and advisors to have one thing in common: To share the values and beliefs of Dr Herman Schwan, fellow physicists, and members of the IEEE. Many ICNIRP members also have or had close funding and scientific relationships with the telecommunications industry. According to Professor Franz Adlkofer (2015): *"A milestone in putting through the interests of the mobile communication industry was the*

establishment of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 1992. It is a non-governmental organization. Michael Repacholi, [later] head of the WHO's EMF Project, managed to get official recognition for this group by the WHO as well as the EU and a series of its member states, among them Germany. Repacholi, first ICNIRP chairman and later emeritus – member, left the WHO after allegations of corruption in 2006 and found a new position as a consultant to an American electricity provider." Adlkofer adds that when the ICNIRP *"established the European safety limits it uncritically based its decision on Schwan's pseudo-theorem [of 10 mW /cm2]. The American safety limits were taken over with only minor alterations"* (see ICNIRP, 1998, 2009, 2020).

Further evidence to support Prof. Adlkofer's observation from the ground-breaking research at The Royal Adelaide Hospital in South Australia, which Michael Repacholi led. Evidence from journalist Mr Stewart Anthony Fist to the UK Parliament's Select Committee on Science and Technology (1999) on this initiative reports that researchers…

> *"conducted two parallel studies on EMF exposure between 1993 and 1995. The research design was checked by a committee of the National Health and Medical Research Council (NHMRC) of Australia (the supreme medical research authority) and the hospital had a special committee supposedly oversighting the day to day activities.*
>
> *The promoter of these two research projects, Dr Michael Repacholi … sold the idea to the electricity supply organisation and cellphone industry as a way to solve their problems once and for all.*
>
> *Repacholi is not so much a scientist (he has no research credentials before this), but is well-known as a spokesman and science administrator. He has long been one of the world's best known and most vocal "No Possible Effects" promoters for both low-frequency mains power and cellphones and therefore had the confidence of both the ESAA and Telstra."* The mobile phone study was funded by *"Telstra (Australia's dominant carrier) to look specifically at possible effects of GSM digital cellphone exposures."*

The GSM study was rigorous and *"had control groups of 100 animals, which were treated identically (down to the use of "sham" exposures), and both were double-blind trials where no one knew which autopsied mice had been exposed and which had not until after the diagnosis of cancer had been determined."* The study's findings were published in Radiation Research in 1997, concomitant with the development of the ICNIRP guidelines published in 1998. This study led by the now Chair Emeritus of the ICNIRP, *"established clearly and with little room for doubt that the industry claim that "cellphone radiation cannot possibly affect biological tissue at non-thermal exposure levels," is a complete lie. And this finding is only one of hundreds which have consistently shown this, with varying degrees of validity and credibility over many years. It fits almost perfectly into the overall "assemblage" of evidence accumulated by many different independent biomedical researchers from many varied studies on animals and cell-cultures"* (Fist, 1999). The study reported that *"Lymphoma risk was found to be significantly higher in the exposed mice than in the controls (OR = 2.4, P = 0.006, 95% CI = 1.3-4.5). Follicular lymphomas were the major contributor to the increased tumor incidence. Thus long-term intermittent exposure to RF fields can enhance the probability that mice carrying a lymphomagenic oncogene will develop lymphomas"* (Repacholi et al. 1997). That is, exposed mice were 2.4 times the greater odds to develop lymphomas than controls.

This extended extract from Fist's statement to the Select Committee on Science and Technology is revealing:

> *"What interests me here is the way in which the release of the information was manipulated—by the scientists, by the hospital, and by the ESAA and Telstra (it is often not clear which)—and sometimes by all of them together.*
>
> *Remember, two and a half years after the completion of the study, not one word of results had leaked out. In the interim, Dr Repacholi had attended dozens of conferences and given dozens of interviews, and still vocally maintained his stance that there was no evidence connecting cellphone exposures to adverse health consequences—knowing all the time that his mice had shown a major, highly significant, increase in basal-cell lymphomas.*

Yet Michael Repacholi told me off-the-record at a London Conference on 15 November 1997 (it is recorded in my journalist's notebook) that the research had turned up "nothing of any significance". ... At the same London conference, he was very vocal in supporting industry claims that there were no studies linking cellphones to adverse health effects and strongly criticised a few scientists who had turned up positive results. There were dozens of people at the conference who can attest to this.

At this time Dr Repacholi was the head of WHO's EMF Project and probably the second most powerful cell-research-funding bureaucrat in the world (Dr George Carlo was the most powerful)—yet he was publicly denying and discounting his own unpublished research.

At that time Repacholi had known for over two years that the Adelaide Hospital research finding was the most significant link yet discovered."

Research in organisations notes the impact of the founders and leaders in shaping an organisation's culture, values, and commitment (Selznick, 2011; Morely et al., 1991). Thus, there is abundant evidence that the ICNIRP, as the creation of Michael Repacholi, implemented his values and beliefs. These are evident in the 'thermal only view' on the physical and biological effects of RFR, which the ICNIRP holds to the present day. It is also apparent that such values and beliefs dominate in fora in which ICNIRP members participate. Take, for examples, that critical peer-reviews of ICNIRP Guidelines and reports where ICNIRP Commissioners and Expert Advisors participated, e.g. in the WHO EMF Committee, European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), and the UK's Advisory Group on Non-ionising Radiation (AGNIR), are essentially compromised and exhibit the same pattern of *"constructive dismissal"* tactics described in initially by Cherry (2000, 2004) (See the following peer-reviewed papers: Maisch, 2006; Maisch, 2009; Adlkofer, 2015; Sage et al., 2016; Starkey, 2016; Hardell, 2017; Carlberg and Hardell, 2017; Walker, 2017; Pockett, 2019; Hardell and Nyberg, 2020; Melnick, 2020; and Buchner and Rivasi, 2020).

How the ICNIRP Constructively Dismisses Scientific Findings

The telecommunications industry, and latterly BigTech firms have through lobbyists, law firms, consulting scientists, targeted scientific research funding and the co-optation of pseudo-independent NGOs such as the ICNIRP, and captured agencies and organisations such as the FCC, FDA and the WHO International EMF Project, disputed the health risks of RFR and scientific findings undermined using what Michaels terms *"junk science"* (Huber, 1993; Michaels, 2008; Walker, 2017). During the 1990s and since this involved the perverse and biased application of epidemiological approaches and statistical methods to reinterpret valid scientific data to arrive at conclusions that support the industry view of no harm or effect. Proof of this comes from Dr. Neil Cherry in his report on the ICNIRP (1998) Guidelines to the New Zealand Ministry of Health and Ministry for the Environment before their adoption (Cherry, 2000, 2004). Dr. Cherry termed the way the ICNIRP-WHO treated extant findings as *"The Constructive Dismissal Approach."* He stated that *"In order to maintain the RF-Thermal View against the extremely strong evidence from epidemiology, animal experiments and of non-thermal mechanisms, the WHO and ICNIRP assessors and their colleagues have developed a set of dismissive methodologies. These include:*

- *Maintaining that the RF-Thermal view as the "consensus of science". This allows the biological mechanism to dominate and epidemiology and animal evidence is dismissed.*
- *Maintaining a contrast between Ionizing radiation and Non-ionizing radiation.*
- *Moving the level of evidence goalpost where for a study to become "evidence" it must first be replicated, whereas in the past each study was evidence and replication was required to "establish" a biological effect.*
- *Promoting strict sets of scientific criteria which are proposed as being necessary for reliable use of the results, e.g. the Bradford Hill "criteria", instead of "viewpoints", and Dr Martin Meltz's 13 experimental criteria for testing genotoxicity (Meltz, 1995). In this way all non-thermal evidence is rejected.*

- *Citing studies which are too small and have small follow-up periods so there is little or no opportunity for cancer to develop, as evidence that radar [RFR] exposure does not cause cancer.*
- *Citing studies which do show significant increases in cancer as showing no evidence of increases in cancer.*
- *Preferring to simply quote the conclusions of papers and reports that state that there were no adverse effects found, while failing to recognize that the data and analysis within the documents do show significant associations, including significant dose response relationships.*
- *Dismissing epidemiological studies on the grounds that populations and exposures are not well defined. Lilienfeld explains that this is a difficulty, but results are still relevant and important. (Lilienfeld et al. 1978).*
- *Dismissing research results one by one and failing to assemble and interpret the whole pattern of research results - the divide to conquer approach.*

All of these are demonstrated methods used by WHO and ICNIRP which amounts to a systematic approach to wrongly dismiss evidence of effects, i.e. Constructive Dismissal."

Reflecting on historical facts and current realities, the following questions arise:

1. If the US Navy NMRI in 1971 identified, based on over 2,000 studies on RFR, 9 thermal effects, and 43 non-thermal adverse health effects viz. 29 physiological effects, 9 CNS effects, and 5 autonomic and peripheral nervous system, why do the industry, ICNIRP, and policymakers persist in the denial of indirect thermal and non-thermal adverse health effects given the findings of thousands of studies since the 1970s?
2. If EPA scientists found EMFs to be a possible carcinogen and probably responsible for a range of adverse health effects in 1990, why did the industry, FCC, FDA, ICNIRP, and policymakers adopt the position that there was no evidence of non-thermal biological and adverse health effects?
3. If the industry's own Wireless Technology Research (WTR) found evidence of risk of adverse health effects in humans (Carlo and Schram, 2001). This excerpt from the letter[9] from Dr. George Carlo[10] to Mr. C. Michael Armstrong, Chairman, and Chief Executive Officer, AT&T Corporation summarizes the findings:
    - *"The rate of death from brain cancer among handheld phone users was higher than the rate of brain cancer death among those who used non-handheld phones that were away from their head;*
    - *The risk of acoustic neuroma, a benign tumour of the auditory nerve that is well in range of the radiation coming from a phone's antenna system, was fifty percent higher in people who reported using cell phones for six years or more, moreover, that relationship between the amount of cell phone use and this tumour appeared to follow a dose-response curve;*
    - *The risk of rare neuro epithelial tumours on the outside of the brain was more than doubled, a statistically significant risk increase, in cell phone users as compared to people who did not use cell phones;*
    - *There appeared to be some correlation between brain tumours occurring on the right side of the head and the use of the phone on the right side of the head;*
    - *Laboratory studies looking at the ability of radiation from a phone's antenna system to cause functional genetic damage were definitively positive and were following a dose-responsive relationship."*

Eminent scientists Frank Barnes and Ben Greenebaum, among hundreds of other scientists from across disciplines, find issues with ICNIRP Guidelines (1998, 2020). Twenty years on from Cherry's (2000, 2004) report to the New Zealand government, they argue: *"Current limits for exposures to non-ionizing electromagnetic fields (EMF) are set, based on relatively short-term exposures. Long-term exposures*

[9] https://www.goaegis.com/articles/gcarlo_100799.html

[10] See also Carlo and Schram (2001) and Kane (2001).

to weak EMF are not addressed in the current guidelines. Nevertheless, a large and growing amount of evidence indicates that long-term exposure to weak fields can affect biological systems and might have effects on human health. If they do, the public health issues could be important because of the very large fraction of the population worldwide that is exposed" (Barnes and Greenebaum, 2020). This is a strong and suitably restrained statement, as is the norm for scientists. They (ibid., p. 1) review a relevant subset of the literature reviewed herein and provide a succinct summary of the issues:

> *"The results of these papers have not been considered convincing or relevant by the [ICNIRP and WHO] panels due to methodological issues, because they did not relate closely enough to human health, and because the experimental results are mixed, showing increases, decreases, or no change in similar situations. However, taken as a group, they do provide strong evidence that weak EMF can be sensed by biological systems, as well as suggestive evidence that fields may affect human health."*

Barnes and Greenebaum (2020, p. 4) also call for additional research to identify new guidelines that limit levels of exposure to mitigate the risks: They argue that *"Eventual guidelines might suggest limiting cell phone calls to X hours per day with exposure levels above Y W/m^2, and for Z days per week exposure should be less than Y W/m^2 to allow the body to reset its [oxidative] baseline. The time between heavy exposures might be initially estimated by looking at recovery times from other stresses such as exercise … A possibility might be that cell phones and WiFi are turned off at night or over the weekend to allow for resetting of the oxidative baseline levels."* If, however, a foetus, child, or adult receives an injury, then these measures may be inadequate. These and other researchers focus on oxidative stress is important, as the ICNIRP and IEEE constructively dismiss a significant body of peer-reviewed science and omit important findings that would certainly alter guideline threshold levels.[11]

How does the ICNIRP Fund its Activities?

Given the worldwide acceptance of the INCIRP and the influence its research and guidelines have on the WHO, governments, regulators, and policymakers generally, it is reasonable to assume that its income and expenditures are significant. The ICNIRP is an NGO that has persistently and consistently denied receiving industry funding. Hence, it declares it has no conflicts of interest at any level. Given the range of its presumed research, investigatory and dissemination activities; the fact that it has 13 sitting commissioners, 25 expert advisors, and presumably office and administration staff; then its income and expenditures must be commensurate with its international standing and influence in shaping public policy on technology and human health. The other standards-making body in the wireless technology sector is the IEEE. The published accounts for the IEEE show that in 2018 its income stood at $531,942,200. These are extracts from the ICNIRP Annual Report 2018. Its annual income for 2018 is shown as €133.254, while its expenditures are listed at €150.959: This troubling. These sums are significantly less than the salaries of university professors sitting on the Commission. A desktop search found no other international NGO of significance with poor financial accounts. A major question arises as to this level of income and expenditure viz. *how can the ICNIRP fund its many activities and deliver high quality, reliable and accurate research outputs and guidelines and disseminate these globally?*

The author was recently invited to attend the European Parliament's Panel for the Future of Science and Technology - Workshop on 5G.[12] In answer to a query to the panel by the author—How can the ICNIRP fund its research activities and finance regular global meetings?—which included ICNIRP Chair Rodney Croft and Eric van Rongen (Vice-Chair ICNIRP)—Dr. Van Ronegan answered in the Chat function that commissioners and advisors fund their own travel etc.: This is just not credible and requires closer examination. There have been numerous questions asked of the ICNIRP regarding the

[11] The author reviewed ICNIRP Guidelines (1998, 2020) and IEEE (2005, 2019) and finds significant lacunae in the literature cited.

[12] https://multimedia.europarl.europa.eu/en/panel-for-future-of-science-and-technology-workshop-on-5g_20201207-1000-SPECIAL-STOA_vd

transparency of its activities and its income (cf. Buchner and Rivasi, 2020)—these issues are now addressed.

Compelling Evidence of Bad Governance and Conflicts of Interests at ICNIRP

The ICNIRP stands accused of unethical behaviour in conducting scientific reviews, conflicts of interest, and questionable governance (Buchner and Rivasi, 2020). Scientists are concerned about the practice of ICNIRP scientists drafting safety guidelines, while also acting as members of key bodies and expert groups responsible for objectively assessing those safety guidelines is anathema to all principles of good governance, let alone good science. It is a *conflict of interest* (Hardell and Carlberg, 2020) writ large and a clear breach of the *separation of duties* required of business (see Manière et al., 2007). It is akin to academics acting as authors and reviewers of their scientific papers. No other area of scientific or business endeavourur would countenance such a conflict of interest or lack of independence. This paper now provides compelling evidence of poor governance and conflicts of interests at ICNIRP.

In a 98-page detailed report on the ICNIRP and its activities, Members of the European Parliament, Michèle Rivasi and Dr. Klaus Buchner find that "*[t]he composition of ICNIRP is very one sided. With only one medically qualified person (but not an expert in wireless radiation) out of a total of 14 scientists in the ICNIRP Commission and also a small minority of members with medical qualifications in the Scientific Expert Group, we can safely say that ICNIRP has been, and is still, dominated by physical scientists. This may not be the wisest composition when your remit is to offer advice on human health and safety to governments around the world."* However, they demonstrate that this makes it easier to ignore or dismiss research from medical and related disciplines. Buchner and Rivasi (2020) observe that *""a closed circle of like-minded scientists" has turned ICNIRP into a self-indulgent science club, with a lack of bio-medical expertise, as well as a lack of scientific expertise in specific risk assessments. Thereby, creating a situation which might easily lead to "tunnel-vision" in the organisation's scope. Two leading experts, Hans Kromhout and Chris Portier, confirmed to us that ICNIRP is a closed, non-accountable and one-sided organisation."* They (ibid.) report that "*In addition to the fact that certain members of ICNIRP, are simultaneously members of the International Committee on Electromagnetic Safety (ICES) of the US-registered Institute of Electrical and Electronics Engineers (IEEE), we have seen further evidence of a close cooperation between ICNIRP and ICES, an organisation in which many people from the media and telecom industries, as well as from the military, are actively and structurally involved. During the current leadership of ICNIRP, these ties have become even closer "with the goal of setting internationally harmonized safety limits for exposure to electromagnetic fields." This must surely be considered as a situation in which conflicts of interest are a real possibility. It is clear from ICES minutes that ICNIRP worked very closely with IEEE/ICES on the creation of the new RF safety guidelines that were published in March 2020. And this implies that large telecom-companies such as Motorola and others, as well as US military, had a direct influence on the ICNIRP guidelines, which are still the basis for EU-policies in this domain."* The Buchner and Rivasi (2020) report provides detailed evidence of a range of conflicts of interests of ICNIRP members, including its current chair.

This paper's review of the relevant literature indicates there are significant moral, ethical, and related questions to be answered by the ICNIRP. One central question concerns conflicts of interests: While Starkey (2016) and Pockett (2019) provide convincing evidence, the studies published by Buchner and Rivasi (2020) and Hardell and Carlberg (2020) are conclusive. The International Committee of Medical Journal Editors provides the following conceptualization of conflicts of interests in the field of medicine, which is of relevance to this study.

> *"The potential for conflict of interest and bias exists when professional judgment concerning a primary interest (such as patients' welfare or the validity of research) may be influenced by a secondary interest (such as financial gain). Perceptions of conflict of interest are as important as actual conflicts of interest…*
>
> *Financial relationships (such as employment, consultancies, stock ownership or options, honoraria, patents, and paid expert testimony) are the most easily identifiable, the ones most*

often judged to represent potential conflicts of interest and thus the most likely to undermine the credibility of the journal, the authors, and science itself. Other interests may also represent or be perceived as conflicts, such as personal relationships or rivalries, academic competition, and intellectual beliefs." [13]

***Table 1 INCIRP Members Influence on Key Committees** (Excerpt from Hardell and Carlberg, 2020)*

Table I. Members of the WHO core group and additional experts of the Environmental Health Criteria Document 2014 (54), EU SCENIHR 2015 (52), the SSM 2015-2020 (93) and ICNIRP commission or the Scientific Expert Group 1992-2020 (94).

Members	WHO, 2014	SCENIHR, 2015	SSM, 2015-2020	ICNIRP, 1992-2020
Emilie van Deventer	X		X	X[a]
Simon Mann	X			X
Maria Feychting	X		(X)[b]	X
Gunnhild Oftedal	X			X
Eric van Rongen	X		X	X
Maria Rosaria Scarfi	X	X	X	X
Jukkka Juutilainen	X			X
Denis Zmirou	X			
Theodoros Samaras		X		
Norbert Leitgeb		X		
Anssi Auvinen		X		X
Heidi Danker Hopfe		X	X	
Kjell Hansson Mild		X		
Mats Olof Mattsson		X		X
Hannu Norppa		X		
James Rubin	X	X		
Joachim Schüz		X		
Zenon Sienkiewicz	X	X		X
Olga Zeni	X	X		
Anke Huss			X	X[c]
Clemens Dasenbrock			X	X
Lars Klaeboe			X	
Martin Röösli	X		X	X
Aslak Harbo Poulsen			X	

[a]WHO Observer in the main commission (95); [b]2002-2011; [c]2020-2024. The table is based on members of WHO, SCENIHR and SSM during the defined time period(s). No other individuals among those within WHO or SCENIHR were found in the list of SSM participants. A total of 15 additional experts in WHO were not members of SCENIHR, SSM or ICNIRP. SCENIHR, Scientific Committee on Emerging and Newly Identified Health Risks; SSM, Swedish Radiation Safety Authority; WHO, World Health Organization; EU, European Union; ICNIRP, International Commission on Non-Ionizing Radiation Protection.

Golomb (2018) points out that the *"[e]ffects of conflicts of interest on research results (as well as on funding, regulatory agencies, legislation and academics) vis a vis RF/MW, has been repeatedly documented and decried."* She cites Richard Smith, Editor in Chief of the British Medical Journal, who argues that financial interests cloud objectivity and who states *"far from conflict of interest being unimportant in the objective and pure world of science where method and the quality of data is everything, it is the main factor determining the result of studies"* (Smith, 2006). She (ibid.) adds that *"[it] has been generally assumed that the disproportionately product-favorable results from industry-funded studies (including less evidence of product harm) arises by virtue of choices, selecting study design, exposure specifics, subjects, and outcomes to support the desired result. (… these can in fact influence outcomes.) But where harms of lucrative products are concerned, there is precedent for industry-funded studies going beyond those factors to hide even large and lethal harms, even for*

[13] International Committee of Medical Journal Editors. Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals. Available online: http://www.icmje.org/icmje-recommendations.pdf (accessed on 20 July 20, 2020).

prespecified or primary outcomes – via means that have the appearance, at least, of fraud…. Special circumstances enabled the apparent shenanigans in those cases to be uncovered. Whether frank manipulation of data to hide harms of lucrative products is the rule or the exception in industry-funded studies is simply not known."

In their analysis of conflicts of interests as they pertain to the activities of the ICNIRP, Hardell and Carlberg (2020) delineate several unequivocal instances of the presence of conflicts of interests. They examine the Swiss government's policy on 5G, which was clearly influenced by the ICNIRP's Martin Röösli, a professor in environmental epidemiology at the Swiss Tropical and Public Health Institute. In issuing the formal statement, he opined: *"Regarding the health issue, the working group concludes that, until now, no health effect has been consistently proven below the given exposure limits."* As Hardell and Carlberg demonstrate, this stands in stark contrast with the views of the majority of scientists and the scientific evidence. Indeed, a study co-authored by Professor Röösli in 2018 found *"a potential adverse effect of RF-EMF brain dose on cognitive functions [of adolescents] that involve brain regions mostly exposed during mobile phone use" (Foerster et al. 2018, p. 1)*. Why would Professor Röösli, like Michael Repacholi before him (Fist, 1999), ignore the findings of his research? Hardell and Carlberg (ibid., p. 2) point to significant conflicts of interests involving Professor Röösli and other members of the government panel. They extend this critique to other members of the ICNIRP viz. in *"2008, the Ethical Council at Karolinska Institute in Stockholm stated that being a member of ICNIRP is a potential COI. Such membership should always be declared. This verdict was based on activities by Anders Ahlbom in Sweden, at that time a member of ICNIRP, but is a general statement (2008-09-09; Dnr, 3753-2008-609). In summary: 'It is required that all parties clearly declare ties and other circumstances that may influence statements, so that decision makers and the public may be able to make solid conclusions and interpretations. AA [Anders Ahlbom] should thus declare his tie to ICNIRP whenever he makes statements on behalf of authorities and in other circumstances' (translated into English)."*

Table 1 above indicates the powerful influence that ICNIRP members exert over key committees in the WHO and EU (Hardell and Carlberg, 2020). Table 2 below examines the membership of the UK's Advisory Group on Non-ionising Radiation (AGNIR) committees, indicating the influential role played by ICNIRP members.

Table 2 INCIRP involvement in the UK's AGNIR

Table 1: AGNIR in 2012 and 2016 and membership of ICNIRP, PHE or DH.

AGNIR 2012		AGNIR 2016	
Swerdlow A.J. (Chair)	ICNIRP Chair of standing committee on epidemiology	Swerdlow A.J. (Chair)	formerly ICNIRP
Conney S.W.	DH	Conney S.W.	DH
Coulton L.A.		Coulton L.A.	
Duck F.A.		Duck F.A.	ICNIRP
Feychting M.	ICNIRP	Feychting M.	Vice-Chair ICNIRP
Haggard P.		Haggard P.	
Lomas D.J.		Lomas D.	
Noble D.			
Mann S.M.	HPA	Mann S.M.	ICNIRP, PHE
Maslanyj M.P.	HPA	Maslanyj M.P.	PHE
Meara J.R.	HPA	Meara J.R.	PHE
		O'Hagan J.O.	ICNIRP, PHE
Peyman A.	HPA	Peyman A.	PHE
		Powers H.	
		Rhodes L.	
Rubin G.J.		Rubin G.J.	
Sienkiewicz Z.J.	ICNIRP, HPA	Sienkiewicz Z.J.	ICNIRP, PHE
		Tedstone A.	PHE
		Young A.	

PHE was formerly known as the Health Protection Agency, HPA. PHE is part of the Department of Health, DH.

In addition, Hardell and Carlberg (2020, p. 4) point out that the…

> *"ICNIRP has not managed to conduct a novel evaluation of health effects from RF radiation. However, as shown in Table [6] several of the present ICNIRP members are also members of other committees, such as the EU Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), the Swedish Radiation Safety Authority (SSM) and the WHO, thus creating a cartel of individuals known to propagate the ICNIRP paradigm on RF radiation […]. In fact, six of the seven expert members of the WHO, including Emelie van Deventer, were also included in ICNIRP […]. Therefore, Emilie van Deventer, the team leader of the Radiation Programme at WHO (the International EMF Project), is an observer on the main ICNIRP commission, and SSM seems to be influenced by ICNIRP. Among the current seven external experts (Danker-Hopfe, Dasenbrock, Huss, Harbo Polusen, van Rongen, Röösli and Scarfi), five are also members of ICNIRP, and van Deventer used to be part of SSM.*
>
> *As discussed elsewhere [(Hardell, 2017)], it is unlikely that a person's evaluation of health risks associated with exposure to RF radiation would differ depending on what group the person belongs to. Therefore, by selecting group members, the final outcome of the evaluation may already be predicted (no-risk paradigm). Additionally, we believe that this may compromise sound scientific code of conduct."*

In relation to ICNIRP membership of the SCENIHR committee, Sage, Carpenter, and Hardell (2016, p. 192) report that SCENIHR never *"answered the question it was appointed to investigate. The Committee has answered a different question, limiting its conclusions to whether certainty or causal effect is established, instead of possibility of health risks... Overall, SCENIHR has not conducted a scientific review process for judging possible health risks. This results in erroneous and deceptive conclusions by failing to conclude such possible health risks do exist. Evidence that SCENIHR has presented clearly and conclusively demonstrates that EMF health risks are possible, and in some cases are established."* Independent researchers conclude that the exercise of bias by, and the presence of, significantly conflicted ICNIRP members was responsible for the obfuscation, erroneous and deceptive conclusions.

Hardell and Carlberg (2020), among many others, echo this conclusion by Pockett (2019, p. 4):

> *"ICNIRP is a self-selected, private (non-governmental) organization, populated exclusively by members invited by existing members. The organization is very concerned to project the image that it is composed of disinterested scientists—indeed all ICNIRP members are required to post on the organization's website detailed declarations of interest (DOIs). However, a closer inspection of these DOIs reveals that a good many of the sections of a good many of the forms remain unfilled, and a detailed list of undeclared conflicts of interest among ICNIRP members has been published by a group of concerned citizens […]. The relevant section of WHO is essentially identical to ICNIRP […]: Michael Repacholi, the founder of ICNIRP, established the WHO International EMF Project (IEMFP) in 1996 and remained in charge of it until 2006 […], when he reportedly resigned after allegations of corruption […] to officially become an industry consultant […]. In 2004, Repacholi stated in a conference presentation that the IEMFP was able to "receive funding from any source through Royal Adelaide Hospital; an agency established through WHO Legal Department agreement to collect funds for the project"—an arrangement that reportedly enabled receipt of annual payments of $150,000 from the cellphone industry […]." Thus, in spite of their stated rules and protestations to the contrary, there have been persistent allegations that both ICNIRP and the relevant section of WHO are riddled with undeclared conflicts of interest."*

So successful is the ICNIRP in influencing the EU and governments globally, including the US federal agencies such as the FCC and FDA, that industry lobbying in this area is now practically non-existent, although that was not always the case (Buchner and Rivasi, 2020, p. 43) viz. the *"European Telecommunications Networks Operators' Association (ETNO) does not lobby for lowering the ICNIRP standards, as these are not seen as part of the "regulatory pressure" that hampers technological*

development. On the contrary: the norms ICNIRP proposes are the "harmonised limits" that ETNO welcomes. All in all, the telecom-sector seems to be quite pleased with ICNIRP's positioning. This deviates from the standard procedure in EU-policy making, where a specific industry concerned will, on essential aspects, always try to influence laws and regulations in its favour through various lobbying strategies. Apparently, in the case of ICNIRP, there is simply no need to do so. At the same time, the insurance sector does not, at present, seem very reassured and does not want to be put in a situation of having to pay potential litigation costs, if and when telecom companies get sued, something that is happening more and more often." The same applies to the US, where the industry has captured the FCC (Alster, 2015).

Hardell and Carlberg (2020, p. 4) conclude the following in relation to conflicts of interest at the ICNIRP and its influence on policymaking:

> *"As shown in Table [6], few individuals, and mostly the same ones, are involved in different evaluations of health risks from RF radiation and will thus propagate the same views on the risks in agencies of different countries associated with the ICNIRP views (...). Therefore, it is unlikely that they will change their opinions when participating in different organizations. Furthermore, their competence in natural sciences, such as medicine, is often low or non-existent due to a lack of education in these disciplines (...). Therefore, any chance for solid evaluations of medical issues is hampered. Additionally, it must be concluded that if the 'thermal only' dogma is dismissed, this will have wide consequences for the whole wireless community, including permissions for base stations, regulations of the wireless technology and marketing, plans to roll out 5G, and it would therefore have a large impact on the industry. This may explain the resistance to acknowledge the risk by ICNIRP, EU, WHO, SSM and other agencies. However, the most important aspects to consider are human wellbeing and a healthy environment."*

The credibility and integrity of the ICNIRP's position are undermined by former ICNIRP members that now recognise RFR as a significant risk to human health (see Lin, 2019). They find themselves in direct opposition to their former colleagues, particularly where the results of the NTP study is concerned. However, current colleagues in IRPA are now voicing similar concerns following the release of the ICNIRP Guidelines (2020).

A Critique of the Ethics of Risk Assessment at the ICNIRP

In correspondence with the author and other scientists, Dr. Rodolfo R. Touzet (CNEA-CIPRACEM), forwarded an email sent to IRPA Executive Committee on Dec 16, 2020, along with a report by the Ibero-American Commission for Radiological Protection of Electromagnetic Fields (CIPRACEM). In the email to IRPA Executive Committee it was stated that: *"From ICNIRP publications it seems that ICNIRP based its main paradigm just on the limitation of the individual exposure to IR. But the selected limits are not tailored to the principles of deontological ethics followed by ICRP. The 'duty' for ICRP is to limit a conjectural probability of deleterious health effects rather than the effects themselves. The 'dose limits' recommended by ICRP are orders of magnitude below the levels of exposure at which those effects are demonstrable. This is not the case for the ICNIRP recommended limits. The availability of biological information and epidemiological studies is lower for NIR than for IR and this should be a reason for ICNIRP to be recommend more conservative limits than ICRP, but this do not seem to be the case."* However, the ethical risk assessments by the ICNIRP are called into further question: *"Since many years ago ICRP has incorporated into its paradigm considerations of teleological ethics and its societal implications. Two fundamental ICRP principles are derived from such ethical doctrines: (i) any decision that alters the radiation exposure situation should do more good than harm, namely such decisions shall be justified; and, (ii) protection against exposure should be the best under the prevailing circumstances, namely radiation protection shall be optimized. It is difficult to find something similar in the ICNIRP recommendations."* Even more damming is the following: *"the ICNIRP recommendations lack of the core ethical values underpinning the ICRP system of radiation protection, namely: beneficence and non-maleficence, prudence, justice and dignity."*

Scientists from CIPRACEM analysed the latest ICNIRP publications and contrasted them with the ICRP Radioprotection criteria, the ethical principles that govern IRPA activities, and the criteria established by the ICNIRP when it was instituted in 1992. This analysis is performed over 10 areas.

1. **ICNIRP Principles for NIR Radiation Protection:** In the ICNIRP Guidelines 2020, the principles of justification and optimization are not evident, and the ICNIRP *"intended to mislead the inadvertent reader."* It is heavily criticized for its exclusion of relevant peer-reviewed scientific studies, and it is stated that *"the ICNIRP does not meet nor does it recommend meeting the Radioprotection criteria established by the ICRP."*

2. **Attitude towards countries that follow ICRP principles:** The *"ICNIRP not only does not follow the principles of ICRP but also, in collaboration with companies, questions, criticizes and takes action in those countries that have decided to follow the ICRP criteria and the recommendations of the European Community (Res 1815/11) and proof of this policy can be seen in the ITU-T Series K document edited by the International Telecommunication Union called "The impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE Guidelines on 4G and 5G mobile network deployment".*

3. **Treatment of animal studies:** "*ICNIRP 2020 Evaluation of 2 EMF animal carcinogenicity studies" concludes by saying, "Together, the limitations of these two studies prevent drawing conclusions about carcinogenicity in relation to RF electromagnetic fields" and discards them...! "In conclusion, ICNIRP* ***discards*** *the relevant studies* ***without consulting*** *IARC or UNSCEAR experts or those responsible for the projects...! But it* ***does not provide scientific information*** *that allows demonstrating that NIRs are not carcinogenic."*

4. **Research needs:** *"CIPRACEM considers that there are two huge fields of research that have not been considered by the ICNIRP and are of fundamental importance, the EMF assessment tools and the Radioprotection methods for the different EMF scenarios." "In summary,* ***it has been experimentally determined that there are "healthy and unhealthy" frequencies*** *and this allows us to determine which are the least harmful frequencies for people's health. (For example, up to 80% of planned 5G frequencies belong to so-called harmful frequency bands). In conclusion,* ***the research is not oriented to those fields that allow optimizing the exposure of people in order to reduce risks****."*

5. **Undue consideration of some Biological effects.** CIPRACEM scientists point out that *"Observing the tremendous amount of scientific literature that demonstrates, for each of these effects, the important role in the causes of cancer, it is inexplicable that [the ICNIRP] declares that they* ***are not relevant to health****."*

6. **The lack of specialists in radiation protection of EMF:** CIPRACEM scientists point out that *the "impact on the health of people, animals and the environment being even greater"* with NIR than those from ionizing radiation (IR). Not only do scientists believe that the ICNIRP lacks appropriate expertise (see Buchner and Rivasi, 2020), unlike the IRPA, it is therefore not addressing "*the physical, biological, dosimetric, medical, engineering and regulatory problems in an integral way, in order to investigate and optimize the uses of EMF and achieve practical solutions"* that protect public health.

7. **IRPA Code of ethics**: CIPRACEM evaluates the ICNIRP in light of the code of ethics it is obliged to comply with: *Inter alia,* the ICNIRP has clear conflicts of interest. "*In short,* ***ICNIRP members work together with the industry (IES /IEEE) to harmonize regulations and do not respect the Radioprotection principles that are established in the IRPA code of ethics****."*

8. **IRPA Guiding Principles for Radiation Protection on Stakeholder Engagement*: "****In the case of Non-ionizing Radiations,* ***an open dialogue and exchange of information with interested parties is not established****, which generates conflicts with the scientific community and with some particularly affected groups, such as hypersensitive people….****it is recommended that ICNIRP develop a constructive dialogue and exchange of information with the scientific community and with those people or organizations that may be affected or exposed to radiation****."*

9. **Compliance with the Statute of creation of ICNIRP**: Several key criteria are argued not to have been met by the ICNIRP viz. The ICNIRP did not present its guidelines for comment to the IRPA. It also failed to collaborate with other NGOs such as the "*the ICRU and ICRP"*. Most significantly the ICNIRP failed to achieve an "*appropriate balance of expertise and the scientific independence of the members…and geographic representation"*. The composition of ICNIRP excludes *"**representatives of Russia, China and India, countries that have made great scientific contributions and possess, and especially Russia, a tremendous and unique experience, has its own regulatory body (RNCNIRP)** and applies with precision and intelligence the principles of ICRP and the Principle of optimization of practices, having established Restriction values **100 times lower than those recommended by ICNIRP**."*
10. **ICNIRP, climate change and global warming**. IRPA members from CIPRACEM point out that *"the objectives of the creation of ICNIRP is the benefit of the environment."* This principle is being ignored as CIPRACEM point out that ICT related CO_2 emissions ***"from 2012 to 2015 it went from emitting 6 million tons of CO_2 to 30 million tons. In other words, CO_2 production quintupled in just 3 years, which was equivalent to adding 5 million cars on the roads. Up to 90% of this consumption was attributable to wireless communication network technologies!"***

In a subsequent email on 30th Jan 2021, Dr. Rodolfo Touzet explained that the IRPA15 Congress considered the proposal but *"did not establish the measures that were proposed to correct the actions of the ICNIRP."* He included links to presentations from Dr. Abel Gonzalez on behalf of CIPRACEM[14] –which summarized the above points—and in by the Chair and Vice Chair of the ICNIRP in response, and by a representative of the WHO at the Congress.

Rodney Croft, Chair of ICNIRP states in response to points made by Dr. Gonzalez that*: "As of 4 years ago [2016], science has concluded that there was no evidence that RF EMF could initiate or promote cancer."*[15] This statement is provably false, in light of scientific evidence cited herein: but even more egregious is the ICNIRP continued dismissal of the WHO's IARC classification of RFR as a "*possible carcinogen"* in 2011 and the epidemiological and experimental evidence since. He then sets out to constructively dismiss both the NTP and Ramazzini studies and a raft of others that identify an association with RFR exposures and cancer endpoints in humans and animals. The distortions to and dismissal of the NTP study was addressed and rebutted comprehensively by Melnick (2020) in Health Physics. Professor Croft deftly avoids any defence of the ICNIRP's dismissal of the overwhelming scientific on the causal association between exposure to RFR and oxidative stress in humans and animals. In addition, the ICNIRP Guidelines and its Appendices (2020), contains similar falsehoods, which are widely critiqued (see, for example, Barnes and Greenebaum, 2020).

Eric Van Rongen, ICNIRP's Vice-chair, addressed several ethical issues raised: He stated that *"[t]he aim of the system of non-ionizing radiation protection is to contribute to an appropriate level of protection against the detrimental effects of exposure to electric, magnetic and electromagnetic fields, optical radiation, infra- and ultrasound."*[16] Van Rongen considers the core principles, justification (any decision to alter exposure must do more good than harm), optimization (exposures should be as low as reasonably achievable (ALARA)), and limitation (application of dose limits). He argues that these *"cannot be applied to all cases of NIR"*—and not at all to wireless technologies, as the ICNIRP Guidelines indicate. The dose criteria are not relevant to RFR from the ICNIRP's perspective. No effects other than heating above certain threshold levels of short term RFR exposure are admitted: Therefore, low-level, long term exposure is not an issue for the ICNIRP as it considers it risk-free. With respect to non-threshold effects, justification and risk tolerability are also *"not issues for ICNIRP."* Van Rongen is equally evasive in terms of optimization, as such considerations do not apply given that ICNIRP has decided on the threshold levels of RFR exposure below which no heating occurs in the short term and therefore no risk of harm exists—he states, *"ALARA [is] not useful below threshold."* Here again, the need to address the limitation of RFR dose and exposure levels is linked with the threshold levels decided upon by ICNIRP and all other factors of concern "constructively dismissed." Finally, in terms

[14] https://youtu.be/-Oqct4yuLa0
[15] https://www.youtube.com/watch?v=k9gHbsiZ8yc&feature=youtu.be
[16] https://www.youtube.com/watch?v=w_42yxIPa0Q&feature=youtu.be

of exposures of the general public, Van Rongen states that they *are "not informed, [and] cannot be expected to take measures to reduce risks."* He adds that the ICNIRP treats foetuses as members of the general public and require no special protection (cf. ICNIRP, 2020).

In her presentation to IRPA, Emilie van Deventer of the WHO states that the IRPA principles will be applied in different ways due to the differences between IR and NIR. The fact that the ICNIRP doesn't appear to take any of the principles seriously, as evidenced by the presentations of the Chair and Vice-chair of the ICNIRP, seems to be lost on her. She states that *"the principle of limitation is the one that has been most employed…and the categories of exposures can be used for non-ionizing radiation, eh, as it is for ionizing."*[17] The limits here are for thermally induced adverse health effects only and dismiss and ignore the risk of non-thermally induced adverse health effects. The following slide is particularly instructive as to the current state of play in RFR NIR protection globally.

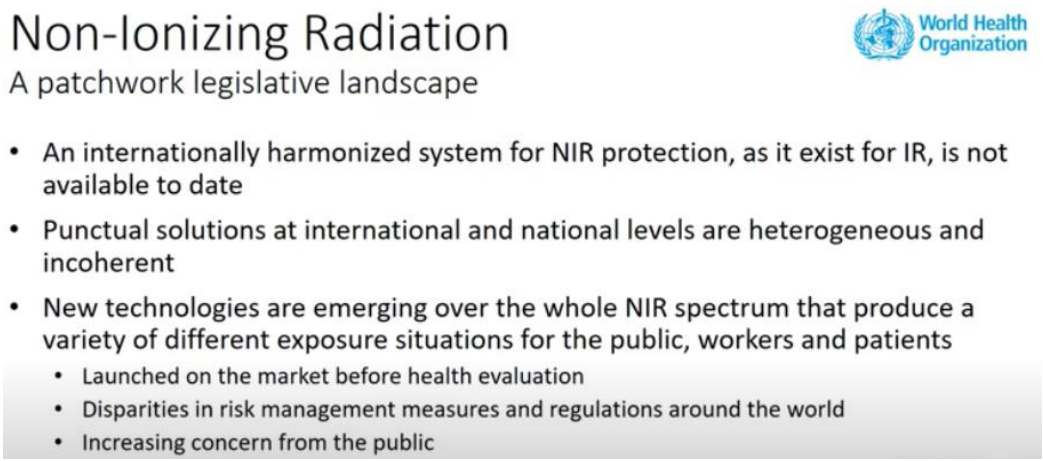

Figure 2 WHO Assessment of NIR Protection

We can infer from this figure that the WHO is concerned about the poor management of risk to public health from RFR: At the root cause here are the deeply flawed and biased ICNIRP guidelines and the fundamental ignorance by policymakers of the large body of extant research on the significant non-thermal health effects of RFR (cf. Starkey, 2016; Pockett, 2019; Hardell and Carlberg, 2020). A majority of scientists argue that their peers in ICNIRP are unethical in their assessment of the evidence and risk to public health. Hence, the increasing body of evidence in peer-reviewed academic research that confirms governments and policy-makers; (1) may be misled by the ICNIRP (Adlkofer, 2015; Hardell, 2017; Hardell and Carlberg, 2019, 2020; Hardell and Nyberg 2020; Pockett, 2019; Melnick, 2019, 2020); (2) are succumbing to pressures from industry and lobbyists (Adlkofer, 2015; Michaels, 2008; Walker, 2017; Hardell and Carlberg, 2020); or (3) are turning a blind eye to scientific and public concerns for economic reasons (Alster, 2015; Hardell and Carlberg, 2020).

Discussion

This paper's findings illustrate the constitution of the path that sees the ICNIRP promote and maintain the dominant logic on the risks posed by wireless technologies. The path was created by the theoretical work of Dr. Herman Schwan: This reflected and aligned with the interests of the military industrial complex in Western democracies (David, 1980). The institutional logics (norms, values, beliefs) underpinning this position focused the attention of scientists away from the risks posed by the non-thermal adverse health effects posed by RFR, at low levels of energy exposure, to thermal effects caused by relatively high levels—this is the Western Path. A different path was created by Soviet scientists, who theorised, based on empirical evidence, that non-thermal effects were just as risky to

[17] https://youtu.be/ljZpDFBP_gM

human health as thermal effects—this is the Eastern Path. While there remains a significant difference in the approaches to risk assessment and management of RFR risk between the West (U.S., UK, EU, Australia, etc.) and Russia (Eastern Europe), wireless technologies are in widespread use globally. In Russia, however, RFR levels are set 100 times less than in Europe and the US, which looks to the ICNIRP (1998) and the IEEE (C95.1-1999, -2005) for risk assessment guidelines. Significantly, Russia's risk-exposed populations appear to be better informed and better protection afforded to children (Grigoriev, 2017).

A Path Constitution Analysis (PCA) of RFR Health and Safety Guidelines

As the Western Path is the focus of this study, this is now examined in terms of the Path Constitution Analysis (PCA, Sydow et al., 2012) analytic lens presented above.

(a) Level interrelatedness: From the beginning, there was a close relationship between scientists performing risk assessments, as they were typically funded by the military and industry organisations and associations. The establishment of the IEEE in 1963 strengthened the industry position in shaping the path. 20 years later that position was further strengthened by the institution of the ICNIRP and its capture of the WHO International EMF Project. Similarly, the industry-IEEE nexus captured the FCC and FDA and its lobbying resulted in the neutralisation of the EPA programme.

(b) Triggering events: The institution of the initial thermal threshold by Herman Schwan; the Tri-service Program of research; the Institution of the IEEE in 1963; the institution of the ICNIRP in 1992; the U.S. Telecommunications Act. 1996; the FCC adoption of IEEE (1991) C95.1-1991 standard in 1996 (Revised in IEEE 2005 and 2019); the institution of the International Committee on Electromagnetic Safety (ICES) in 2001; the publication of the similar ICNIRP Guidelines in 1998 and updated relaxed 5G guidelines in 2020.

(c) Non-ergodic processes; different outcomes were possible in the 1950s and again in the late 1960s and early 1970s when the research from Eastern Europe was catalogues and assessed. However, industry interference and lobbying that helped self-reinforcement of the dominant logics saw the range of options narrowed, despite research being conducted by the EPA and the findings of independent research.

(d-e) Self-reinforcing processes and Lock-in: As indicated, self-reinforcing processes in the 1990s led to institutional, regulatory, and technological lock-in to the dominant logic of thermal only adverse health effects and dismissal of research indicating biological and non-thermal effects.

(f) Multiple Actors: This process saw multiple actors that intentionally or unintentionally extended the path in time-space, rendering it resilient in the face of increasing challenges from independent research—the majority view: The findings of industry-sponsored research, while a minority view, underpinned the dominant logics.

A Retrospective Ethical Risk Analysis

In term of the retrospective eRA which is now undertaken, the first observation to be considered is that there was concern in the U.S. military and defence industry (among others in the West) regarding exposure to RFR from radar and radio sources (Goldsmith, 1997): Initial risk assessments were conducted by Tri-program researchers, industry and universities, as indicated. The need for risk management was negligible given the belief by physicists that RFR exposure had only thermal effects above high transmission levels to which military and occupational personnel were most at risk, but which could be controlled. The general public were, from the outset, not considered to be at any risk, and therefore not consulted. However, as Goldsmith (1997) review revealed, that was and remains the case. The eRA lens (Hansson, 2018) is now employed to the evidence presented in the foregoing analysis of the institutional environment in question.

1. **Three different categories of people identified:** (i) People at risk: military and occupational personal, all members of the general public, including foetuses and children. those in society exposed to risk; (ii) those who benefit from society accepting the risk;

Researchers (career progression), military organisations (freedom to deploy hazardous wireless technologies free from oversight), and especially telecommunications and technology companies (wireless technologies underpin multitrillion $/€ industries); and (iii) Those who make the decisions on risk: Military-industrial complex researchers initially, university research teams with grants from the former, the IEEE from the mid-1960s and into the 1990s. ICNIRP-IEEE researchers from the mid-to-late 1990s (IEEE, 1991, 1999; ICNIRP, 1998). These decisions were validated by IEEE-related and ICNIRP commissioners/advisors who sat on other fora.

2. **Three different types of roles are identified**: (i) Those exposed to risk; (2) those benefiting from the risk; and those who make decisions on risk assessment and management, including government regulations. These roles overlap, however.

    a. Some who are exposed to risk also benefit from the risk (e.g., principals and shareholders in telecoms and technology firms) and also decision-makers (professors and engineers are promoted within their communities; policy-makers see enormous contributions to national economies from wireless RF licenses, corporate taxes, and sales and income taxes). These actors have superior knowledge of the threats from RFR and human vulnerabilities and may take mitigating action to lower risk exposure. The vast majority unknowingly accept the risk for what are immediate benefits of wireless technologies. The evidence would indicate that over the long term, the risks, hazards, and adverse health effects may outweigh the benefits, as with a whole range of environmental toxins.

    b. Some who are exposed to the risk make decisions regarding risk assessment and management for entire societal populations. Those individuals normative and/or ideological adherence to the dominant logic is, given the findings of cognitive psychology, demonstrably based on a tendency to find arguments and evidence to support their hypotheses and dismiss arguments and proof that refute their hypotheses (Kunda, 1990; Hahn and Harris, 2014).

    c. Decision-makers on risk assessment and management based on the dominant logics benefit in significant ways from their decisions: The careers of professors and engineers contributing to ICNIRP and the IEEE benefit from their participation in guideline and standard-setting. Despite conflicts of interest, several ICNIRP commissioners received research funding and consulting remuneration from industry: Many sit on influential committees such as in the WHO and EC. They also advise the FDA and FCC, among others. IEEE members hold influential positions in industry and develop standards that favour wireless technologies' efficient and effective operation without proper reference to or consideration of the science on associated non-thermal adverse health effects. Industry members, their associations and lobbyists who are substantial beneficiaries also influence those charged with risk management, such as politicians and policymakers—the latter benefit through increased revenues through taxes and licenses. Industry figures, politicians, policymakers, and scientists are demonstrated as having strong beliefs that inform motivated cognition and reasoning and self-serving bias (Bardon, 2019). Take, for example, Drummond and Fischhoff (2017, p. 9587) find that *"individuals with greater science literacy and education have more polarized beliefs on controversial science topics."* Politicians and policymakers are similarly prone to motivated cognition and reasoning (Washburn and Skitka, 2018; Bardon, 2019)): This renders their attitudes and preferences for risk assessment and risk management decisions that support their hypotheses and positions. The more long-term and less visible the risk, the greater the likelihood that less powerful in society bear the social, economic, and welfare costs of risk outcomes.

3. **Associated Analyses:** In terms of *individual risk-benefit weighing*, evidence has been presented that the public is not being informed of the risks of non-thermal adverse health

effects by industry, risk decision-makers, or policymakers. Evidence from peer-reviewed scientific studies indicates that foetuses and children bear the most significant risk, and this risk is global. Taleb (2012) argues that the societal effects of low-risk phenomena are enormous, given the numbers of people adversely affected. This places a particular ethical burden on those assessing risks or charged with managing the risks in question. In a *distributional analysis*, one can immediately discern that if the psychological and/or physiological development of children is compromised or genetic changes result, then the costs/losses outweigh the immediate benefits. Likewise, a *rights analysis* indicates that those that receive the least benefits bear a disproportionate risk due to information asymmetries. An information asymmetry and exclusion of social input into either risk assessment or management is leading to powerful interests dominating the less-powerful majority in society. These issues are exacerbated by a failure of independent *subsidiary risk roles*, such as those of health experts and journalists. Both fall prey to the influence of the dominant logics of powerful actors within the institutional environment. It is also the case that the press as media outlets and often with corporate interests aligned with the technology sectors, accept, for the most part, the dominant logic and fail consistently to report on independent scientific research, which is the majority view, but the subservient logic.

This discussion section indicates that ethical risk analysis and management of RFR exposures have not and is not presently happening: This has significant implications for global health and well-being. Key organisations and the actors that constitute them, the ICNIRP, the IEEE, the WHO, the FDA, and FCC, all have significant ethical questions to answer. So too do industry executives who have, since the 1990s, been aware of the association between RFR exposure and adverse health effects in humans.

Conclusions

The introduction and widespread use of wireless digital technologies in society date from innovations in the 1970s and 1980s. At no point was there a cost-benefit analysis of wireless technologies that weighted the apparent benefits of enhanced communication and information access and exchange against the unintended consequences of, and risks to, human health. Driven by '*technological fundamentalism,'* and the general belief that digital technology is neutral, and therefore carries no unintended consequences or risks, politicians, policymakers, and society were willingly misled by the

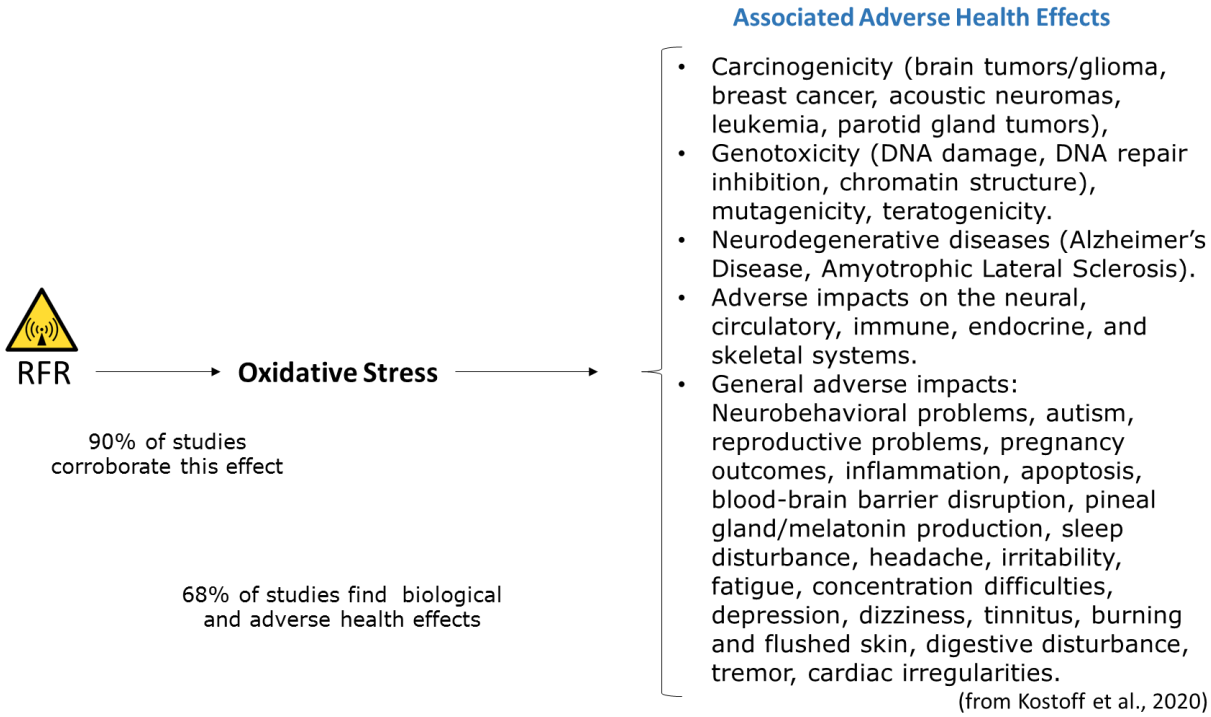

Figure 3 An established RFR Mechanism of Action and Associated Outcomes

telecommunications industry in the U.S., UK, and Europe into believing that wireless technologies were and are safe. The ICNIRP, IEEE, FCC, and FDA are complicit in this. What should have happened when the risks were identified by the U.S. Naval Medical Research Institute, and verified by subsequent studies, is that governments should have limited the scope of technological change in line with independent scientific research on thermal and non-thermal risks. Professor Nassim Taleb argues, *"[o]ur record of understanding risks in complex systems (biology, economics, climate) has been pitiful, marred with retrospective distortions (we only understand the risks after the damage takes place, yet we keep making the mistake), and there is nothing to convince me that we have gotten better at risk management"* (Taleb, 2012). This is certainly the case where the risks to public health from RFR exposure are concerned.

Dr. Christopher J. Portier, when Associate Director, National Institute of Environmental Health Sciences and Director, Office of Risk Assessment Research, co-authored an article with Dr. Wendy Leonard in Scientific American, following the initial release of the NTP study findings in 2016. They conclude that *"[c]ellphones probably cause cancer... We don't yet know the risk for a given level of exposure in humans. We need more data in this area, not only for cellphones, but for Bluetooth devices, WiFi and all the other RF-EMF devices out there"* (Portier and Leonard, 2016). Arguments presented earlier indicate that there is sufficient scientific evidence of risks to human health to temporarily halt any further deployment of wireless technologies in the environment, pending the results of independent and relevant research into "unknowns," such as the effects of the novel and complex exposures to 5G. Such a temporary moratorium could bring several advantages: Public policy would be seen as prudent in light of the further strengthening of the evidence of harm to people and the environment. This is likely if the adverse health risks from wireless technologies (including 5G) follows the trajectory of many other human innovations, where both harm and exposures expanded and became more evident with time (EEA, 2001, 2013).

Figure 3 summarizes the research findings cited in this paper on the adverse health effects from RFR exposure caused by oxidative stress (see Kostoff et al., 2020). It provides compelling reasons for why immediate action is necessary. It summarises the evidence of risk and indicates the role of oxidative stress in producing the various impacts on human health and well-being. Taking adverse health effects, the human, animal, and cellular evidence from scientific studies on brain tumours and other cancers, neurological effects, and developmental/reproductive effects is strong enough to justify action by policymakers to reduce potentially harmful RFR exposures. Children are particularly vulnerable and their risk from exposure is very high (Belyaev et al., 2016; Birks et al., 2017; Divan et al., 2008, 2012; Gandhi et al., 2012; Grigoriev and Khorseva, 2018; Han et al., 2010; Morgan et al., 2018; Melnick, 2020). However, due to the relatively low background incidence of the cancers, their range, and the long latency of cancers in the general population (i.e., an average of 20-25 years for solid tumours), robust epidemiological evidence suggesting the carcinogenicity of RFR will not be available in the short term. That is, in less than 10-20 years since first exposures. Nevertheless, as indicated, prominent oncology researchers strongly argue that there is sufficient evidence to take precautionary action now to protect human health and wellbeing (Hardell and Carlberg, 2020). An additional, and more immediate concern, is the range of neurobehavioral and neurodegenerative disorders, including EHS, that are increasingly linked to RFR exposures (cf. Golomb, 2018; Belpomme and Irigaray, 2020). However, in response to the mounting evidence of these and other adverse health effects, the telecommunications and technology industries sow doubt. At the same time, most policymakers use that doubt as an excuse for inaction.

Following Barnes and Greenebaum (2020), and drawing on observations made by Hansson (2009, 2013), the following concluding observations are posited. An estimation of the risk and hazards to society of the disease endpoints presented in Figure 3 is daunting and will take considerable scientific effort and time. However, taking oxidative stress as an endpoint may produce insights into the risks posed to society. We have seen that up to 90% of studies corroborate the association between RFR exposures and oxidative stress. There is also unanimity in medical science that oxidative stress contributes to many diseases, including cancer, whatever the root cause. If RFR were the only vector responsible for oxidative stress, then a 1% increase in the incidence of all disease endpoints to which it contributes would be considered catastrophic from a public health perspective. It would also be a clear

signal above the epidemiological noise. However, environmental toxins are numerous, as is their influence on oxidative stress in humans (Münzel and Daiber, 2018). Thus, a hypothetical 1% increase from 10% to 11% in disease outcomes may not be considered problematic. Nevertheless, taking EHS as one disease endpoint in which oxidative stress is implicated will help estimate the risk to society. Johansson (2015) estimates that over 3% of Swedish people have a functional impairment due to EHS: However, Huang et al. (2018) conclude that in developed nations, the incidence may be closer to 5% of the population (cf. Belpomme et al., 2018). Thus over 390 million people globally may be affected directly by RFR exposures and suffer EHS-related functional impairments. Furthermore, medical practitioners may attribute their symptoms to other causes. Taking into account the combinatorial effects of RFR and other vectors in elevating oxidative stress and increasing the probability of the disease endpoints listed in Figure 3 in people, especially children, then the consequences of not invoking both the ALARA and precautionary principles become evident. The scientific evidence is that humanity may be faced with a silent health catastrophe.

The consequences of not facing the scientific truth and addressing the risks RFR poses is eloquently stated in the concluding paragraph of *Deceit and denial: The deadly politics of industrial pollution*: It may never *"be possible to evaluate the lost potential of individuals whose intelligence has been slightly lowered, whose behavior has become a bit more erratic, whose personalities have been altered in ways imperceptible to scientific measurement. We will never know the social, economic, and personal costs to society from the lost potential of our citizens"* (Markowitz and Rosner, 2013). These points are reinforced in context of the association between RFR exposures and cancer by Hardell and Carlberg (2021, p.10) who state that there were *"missed opportunities for cancer prevention exemplified by asbestos, tobacco, certain pesticides and now RF radiation. No doubt economic considerations are favored instead of cancer prevention. The cancer victim is the loser in terms of suffering, life quality and shorter life expectancy. Also the life for the next-of-kin is affected. A strategy to sow doubt on cancer risks was established decades ago and is now adopted and implemented in more sophisticated way by the telecom industry regarding RF-EMF risks to human beings and the environment. Industry has the economic power, access to politicians and media whereas concerned people are unheard."*

The only note of hope that can be offered is that the widespread use of wireless technologies is relatively recent. Thus, if we act now to inform society of the known risks our wireless technologies pose, citizens can then be enabled to learn how to use their digital technologies to enrich their lives and livelihoods without endangering their health and well-being and that of their children. And this will also stimulate innovation in communications and help to diversify the ways in which we can communicate effectively via both wired and wireless technologies. But first, we need to combat the deceit and denial of vested interests. We need to ensure that politicians and policymakers inform themselves of the full facts, not only the industry perspective, and to ensure that they act ethically and in the interest of public health and well-being.

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