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Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation

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Abstract: The Advisory Group on Non-ionising Radiation (AGNIR) 2012 report forms the basis of official advice on the safety of radiofrequency (RF) electromagnetic fields in the United Kingdom and has been relied upon by health protection agencies around the world. This review describes incorrect and misleading statements from within the report, omissions and conflict of interest, which make it unsuitable for health risk assessment. The executive summary and overall conclusions did not accurately reflect the scientific evidence available. Independence is needed from the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the group that set the exposure guidelines being assessed. This conflict of interest critically needs to be addressed for the forthcoming World Health Organisation (WHO) Environmental Health Criteria Monograph on Radiofrequency Fields. Decision makers, organisations and individuals require accurate information about the safety of RF electromagnetic signals if they are to be able to fulfil their safeguarding responsibilities and protect those for whom they have legal responsibility.

Keywords: AGNIR; brain; cognition; development; EEG; electromagnetic; fertility; genotoxicity; health; ICNIRP; immune; membranes; misleading; oxidative stress; proteins; Public Health England (PHE); symptoms; tumours; wireless; WHO.

Introduction

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) set international exposure guidelines for radiofrequency (RF) electromagnetic fields in 1998 (1). Conclusions from subsequent ICNIRP reviews have supported the guidelines. Within the United Kingdom (UK), Public Health England (PHE) commission scientific reviews by the Advisory Group on Non-ionising Radiation (AGNIR) to assess the safety of RF fields. AGNIR reviews, along with PHE in-house assessments of exposures, form the basis of PHE's advice on the safety of RF signals. This guides the UK government, organisations and decision makers when assessing the safety of wireless devices and infrastructure. The latest AGNIR review (2) has also been relied upon by health protection agencies around the world, including the Australian Radiation Protection and Nuclear Safety Agency (3) and Health Canada (4).

The majority of the global population absorb RF radiation on a daily basis from smartphones, tablet computers, body-worn devices, Wi-Fi and Bluetooth transmitters, cordless phones, base stations, wireless utility meters and other transmitters. For public health to be protected, decisions need to be based on accurate information. The AGNIR report is considered here for conflicts of interest and scientific accuracy.

Conflicts of interest

PHE stated, "*The 2012 AGNIR report considered whether there was evidence for health effects occurring in relation to exposures below the ICNIRP levels*" (5). At the time of writing the report, the chairman of AGNIR was also chair of the ICNIRP standing committee on epidemiology. Currently, six members of AGNIR and three members of PHE or its parent organisation, the Department of Health (DH), are or have been part of ICNIRP (Table 1). When the group charged with assessing whether there is evidence of health effects occurring at exposures below current ICNIRP values have members who are responsible for setting the guidelines, it introduces a conflict of interest. How can AGNIR report that the scientific literature contains evidence of harmful effects below the current guidelines when several of them are responsible for those guidelines? PHE provide

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the official advice on the safety of wireless signals within the UK, but having members in ICNIRP introduces a conflict of interest which could prevent them from acknowledging adverse effects below ICNIRP guidelines.

PHE (the then Health Protection Agency) responded to the report with "*The Health Protection Agency welcomes this comprehensive and critical review of scientific studies prepared by the independent Advisory Group on Non-ionising Radiation*" (6). The implication was that an independent group had produced the report and presented it to PHE. However, at the time of writing, 43% of those in AGNIR were from PHE or the DH (2) (Table 1). PHE had misleadingly welcomed the report which they were involved in preparing.

Scientific accuracy

The executive summary of the AGNIR report included "*Taken together, these studies provide no evidence of health effects of RF field exposures below internationally accepted guideline levels*" [page 3 of the report (2)] and "*the evidence considered overall has not demonstrated any adverse health effects of RF field exposures below internationally accepted guideline levels*" [page 4 (2)]. Accuracy is vital when most people only read the executive summary and overall conclusions from a 348-page report and national and international public health decisions and exposures are based on them. These conclusions did not accurately reflect the evidence, as described in examples below.

(a) Studies were omitted, included in other sections but without any conclusions, or conclusions left out; (b) evidence was dismissed and ignored in conclusions; (c) there were incorrect statements. Terms such as 'convincing' or 'consistent' were used to imply that there was no evidence. Some examples fall into more than one category.

(a) Studies omitted, included in other sections but without any conclusions, or conclusions left out

Only 7 studies were included in the section on reactive oxygen species [ROS; page 94 (2); Figure 1]. These were summarised by "*production of reactive oxygen species (ROS) were increased in some studies, but not others*" [page 106 (2)]. At least a further 30 studies relevant to ROS or the possible resulting damaging state of oxidative stress were included throughout the report, but with no reference to ROS or oxidative stress within the main text for 16 of these (listed in Supplementary Information, SI) and no mention of this subject in any other summaries or conclusions. At least 40 studies were omitted (using AGNIR restriction to the English language; identified from PubMed and EMF-Portal databases or references within the papers; SI). If these had been included, 79% of studies (61 out of 77) would have demonstrated evidence of significantly increased ROS or oxidative stress in response to

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.

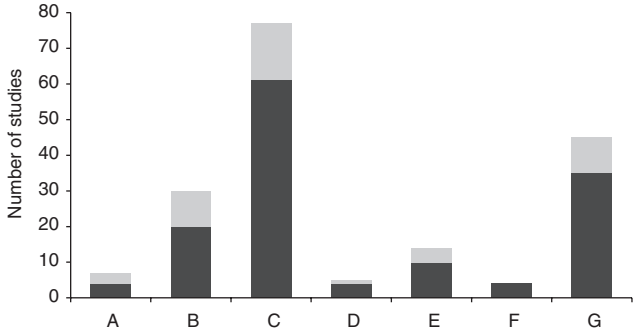

Figure 1: Comparison of the number of studies included in the AGNIR report with those that could have been, for ROS, oxidative stress or male fertility.
(A) studies included in the ROS section; (B) studies scattered throughout the report on ROS or oxidative stress (but with no summary or conclusion); (C) studies which could have been included for ROS or oxidative stress; (D) studies included on male fertility in the cellular studies chapter; (E) studies included on male fertility in animal studies; (F) studies included on male fertility in humans (in vivo); (G) studies which could have been included for male fertility. Dark shading indicates evidence of significant increase of ROS or oxidative stress, adverse effect on male fertility or altered male testosterone concentrations in response to a radiofrequency field; light shading indicates no significant increase of ROS or oxidative stress, adverse effect on male fertility or altered male testosterone concentrations. Studies are listed in SI.

RF fields (Figure 1; SI). By only including a few of the available studies, not referring to many scattered throughout the report and not mentioning ROS or oxidative stress in any conclusions or the executive summary, this important area of research was misrepresented. Oxidative stress is a toxic state which can lead to cellular DNA, RNA, protein or lipid damage (7, 8), is accepted as a major cause of cancer (7), as well as being implicated in many reproductive, central nervous system, cardiovascular, immune and metabolic disorders (7–14).

The conclusion for male fertility studies in animals was "*A substantial number of studies have investigated the effects of RF fields on testicular function, principally in rats, and most report large, obvious effects. However, these results are largely uninterpretable due to inadequate dosimetry or other shortcomings in the studies, and thus are unsuitable for the purposes of health risk assessment. One well-conducted study reported no effects on testicular function in rats exposed to 848 MHz CDMA signals*" [page 191 (2)]. For male fertility in humans (in vivo), it was concluded, "*The evidence on the effect of RF fields on sperm quality is still weak and the addition of the two new studies does not allow reliable evaluation of the presence or absence of a health effect. Some suggestive positive results, although not convincing, give justification for further studies with improved methods. The evidence on effects on male subfertility is very limited, and allows no conclusions*".

At least 22 studies on male fertility were omitted (AGNIR restriction to the English language; identified from PubMed or EMF-Portal databases or references within the papers; listed in SI). Considering those identified as included throughout the report (excluding three subsequently retracted, SI), 78% of studies (18 out of 23) described significant adverse effects on sperm, male reproductive organs or changes in male testosterone concentrations (SI). If the 22 references identified as omitted had also been included, this would have been 35 out of 45, 78% (Figure 1; SI). Isolating small samples of evidence in chapters on cells, animals or humans (Figure 1) may have made it easier to dismiss significant effects on male reproductive health. Inaccurately, in the overall and executive summaries, the evidence for adverse effects on male fertility disappeared: "*Despite many studies investigating effects on male fertility, there is no convincing evidence that low level exposure results in any adverse outcomes on testicular function*" [page 192 (2)] and for humans, in vivo, "*The limited available data on other non-cancer outcomes show no effects of RF field exposure*" [page 4 (2)]. The term 'convincing' is subjective and can erroneously imply that there is no evidence. The human data on male fertility did not show "*no effects of RF field exposure*".

Some studies, mostly those which had tested signals from real mobile devices, were dismissed as uninterpretable because they had not described the dosimetry, the process of determining internal electromagnetic quantities relating to exposure in tissues, in enough detail. Limited descriptions restrict possible interpretations, but do not make them uninterpretable. If the question is 'do mobile phone signals damage male fertility?', real phone signals are highly relevant because they allow possible effects of the complex patterns of fields to which humans are exposed to be investigated. ICNIRP only accept thermal effects of RF fields and focus on average energy absorbed. Highly controlled, simulated signals with descriptions of overall specific absorption rates (SARs) are suited to the assessment of temperature rises in cells or tissues. Real signals make it more difficult to measure average energy, but have characteristics which controlled, simulated signals lack. The complex field patterns, with variable peak field strengths and intervals between transmissions, may influence biology in ways that controlled, simulated patterns cannot, but they are not represented by time-averaged, duty factor reductions of described energy absorption. Responses to RF fields can be greater for intermittent exposures than continuous

(15, 16) and depend upon the pulse characteristics for the same average power (17). Effects can be dependent on frequency, modulation, signal strength (intensity windows), durations of exposure and polarisation (18, 19). For the nervous system, complex signals from real devices may modulate neuronal activity, similar to endogenous electric field ephaptic (non-synaptic) coupling in the brain (20). There is evidence that endogenous electric fields feedback to modulate neuronal activity (21). Fields with amplitudes similar to those found in vivo, applied to neocortical brain slices, modulated and entrained neuronal spiking activity (21). Irregular patterns of fields with complex dynamics, which mimicked in vivo fluctuations, entrained neuronal activity more strongly than sine waves (21). There are valid reasons for testing the effects of signals from real mobile devices, and dismissing these limited and misrepresented the evidence.

The summary for neurocognitive effects in humans stated, "*Studies of cognitive function and human performance do not suggest acute effects of exposure to RF fields from mobile phones and base stations*" [page 226 (2)]. But acute detrimental effects on cognition were omitted from the report (22–25) or mentioned in different sections (26–29). Increased errors during a memory task (26), slowed performance (27) or decreased accuracy in a cognitive test (28) were reported in the electroencephalogram (EEG) section [pages 209–213 (2)]; slowed performance in cognitive tests (29) were reported under sleep [page 215 (2)]. Omitting the studies which found effects in the relevant section led to an incorrect conclusion.

For symptoms in humans, "*Sufferers differ in terms of the type of symptoms that they report, the speed with which symptoms develop and the types of electromagnetic field that appear to be problematic*" [page 232 (2)]. Acute provocation studies in humans expose all subjects to the same short electromagnetic signal to see whether they all respond with the same immediate symptoms. If the speed with which symptoms develop and types of trigger differ between individuals, then in a group overall a lack of significance might be expected for identical acute provocations, but this does not mean that some individuals cannot respond to certain fields given adequate exposure durations, intervals between provocations and low background electromagnetic fields, as has been reported (30, 31). The executive summary concluded, "*The evidence suggests that RF field exposures below guideline levels do not cause acute symptoms in humans*" [page 3 (2)], without explaining limitations.

Many of the longer-term observational studies described significant associations of RF exposures with symptoms, albeit with limitations in study designs: "*While some, though by no means all, of the studies reviewed above appear to suggest an association between mobile phone use and symptoms…*" [page 245 (2)], followed by *"almost all of the studies share a fundamental methodological problem which makes it difficult to draw any firm conclusions from them: these studies relied upon the participants' own descriptions of their mobile phone usage as the exposure variable for their analysis and on self-description of symptoms while knowing exposure status*" (2). Longer-term studies on symptoms were omitted from the executive summary.

No mention was made of the World Health Organization (WHO) International Agency for Research on Cancer (IARC) classification of RF fields as a possible human carcinogen in 2011, which was based on limited evidence supporting carcinogenicity below ICNIRP guideline values (32).

(b) Evidence dismissed and ignored in conclusions

For in vitro membrane effects, the report showed that all studies included (seventeen (33–49); non-blood-brain barrier (BBB)) described significant responses to RF signals except for one, which had tested extremely high powers, far greater than ICNIRP guidelines, that heated the tissue [250–3600 W/kg time-averaged SAR (50); pages 102 and 103 (2)]. This heating study had reported an effect, an in vitro recoverable decrease in population spike amplitude in the hippocampus in response to the RF signal, but no effect on long-term potentiation (50). The report text also mentioned that Falzone et al. had found no changes to the cell membrane [(51), page 101 (2)], but they had measured markers of apoptosis, programmed cell death, not direct effects on membranes; this paper was not included in the table of studies on membrane effects. The membrane studies were weakly dismissed: "*In general, most studies report finding effects on cell membranes when exposures are made at mobile phone frequencies. However, the effects reported are varied and, although the majority find effects, neither is this unanimous nor does it necessarily provide supporting evidence of a consistent effect. The variety of cellular systems and exposures makes comparisons of the effects on the cell membrane problematic and without independent replication it is difficult to assess the robustness or even the validity of the findings.*" Studies had looked at a range of effects and all, below high power heating, reported significant changes, strengthening the validity of the findings.

For direct effects on proteins, 15 out of 16 studies listed found significant effects of RF fields [pages 103–105 (2); (52–67) effect; (53) no effect]. The conclusion was "*In general, most of the studies that have investigated changes*

in protein function or structure due to exposure to RF fields have found effects. However, at the present time the effects have not been demonstrated to be robust by independent replication; so although the concept of a direct effect of RF field exposure on protein structure is interesting, further research is needed to establish if this is a real phenomenon." Ninety-four percent of the studies listed on direct effects on proteins, from 14 different groups, found significant effects, but the conclusion was turned around to imply that these may not be real.

"*Where replications have been undertaken they do not support the original findings. This continued lack of robust evidence makes the possibility of an effect of RF fields on cells more unlikely*" [page 105 (2)]. An effect on cells is not unlikely when there were significant effects in all of the relevant studies on membranes (excluding BBB), all of the studies except one on direct protein effects, the majority of the studies on oxidative stress or male fertility, all of the included in vitro genotoxicity studies on epithelial cells [see c; page 84 (2)] and 47% of in vitro genotoxicity studies which could have been included in the report (see c; SI).

"*Studies on cell membranes and direct effects on proteins mostly found effects of RF field exposure. However, no conclusions can be made as there are no common patterns of exposure conditions or types of effects caused by the exposure*" [page 106 (2)]. Out of 33 studies on direct effects on proteins or cell membranes, 32 described significant effects of RF signals below high power heating, but these disappeared in the conclusions.

By the end of the report, the conclusion on cellular studies had incorrectly become "*There are now several hundred studies in the published literature that have looked for effects on isolated cells or their components when exposed to RF fields. None has provided robust evidence for an effect*" [page 318 (2)].

A summary for human brain EEG recordings stated, "*the EEG studies published since 2003 do provide some evidence that RF fields could influence brain function, and this should remain an area of interest*" [page 226 (2)]. Many EEG studies (awake or asleep subjects) reported changes in electrical field potential oscillations, evoked responses or interhemispheric coupling, but these were dismissed: "*it remains unclear whether these RF effects, if they exist, are material to human health or not*". Electrical field potential oscillations can synchronise activity of local networks (21) or propagate signals over large regions, controlling brain developmental processes, including neurogenesis, apoptosis, neuronal migration, differentiation and network formation (68). Oscillations have been linked with active processing or inhibition of cognitive functions (69) and cyclic modulations of neuronal excitability (21). References available at the time of the report describing behavioural problems (70–72) and changed psychomotor performance (73) associated with pre-natal or childhood RF exposures, cell death and reduced cell numbers in the brain (74–83) and cognitive inhibition (22–29, 78, 79, 84–88) supported the possibility that RF-induced changes in electrical activity could contribute to altered brain development or cognition.

The executive summary included "*There has been no consistent evidence of effects on the brain, nervous system or the blood-brain barrier, on auditory function, or on fertility and reproduction*" [page 3 (2)]. The term 'consistent' dismissed areas for which the majority of studies had found adverse effects, such as male fertility. Of the studies included in the report on pregnancy and development, which quantified effects of pre-natal or early neonatal RF exposures on neuronal cell numbers in the developing brain [pages 184–187 (2)], four found significant decreases: pyramidal cells in the rat hippocampus (74), granule cells in the rat dentate gyrus (75), Purkinje cells in the mouse cerebellum (76) and a transient increase in neurogenesis of the subventricular zone following 8 h of RF exposure over 2 days, but a long-lasting decrease in neurogenesis following a 24 h exposure over 3 days (77), measured from proliferating cells in the rat rostral migratory stream. One study described no effect on neuronal numbers in the mouse hippocampus (89). Whilst not all reported effects, the studies supported RF exposures decreasing neuronal numbers in the brain during pre-natal and early neonatal development at least in some circumstances (74–77). The executive summary misleadingly implied that because not all studies reported the same effects, RF signals have no effect.

The AGNIR report suggested that symptoms in humans may be caused by people's perception of being exposed, rather than the actual electromagnetic fields [page 246 (2)]. Imagining a signal to be present is unlikely to explain all responses, particularly symptoms reported in response to RF signals under blind or double-blind conditions (30, 31, 90). Many other studies support biological responses being related to the electromagnetic signal, including evidence from cultured cells, in vitro preparations, animals, plants or asleep humans, none of which reacted with significant changes because they imagined that RF signals were present. That living things can respond to low power RF signals is now supported by a large body of research.

(c) Incorrect statements

For child development [page 260 (2)], maternal mobile phone use during pregnancy was associated with

behavioural problems in children at the age of 7 (70, 71) and lower psychomotor performance was described for children of mothers who had the highest mobile phone use during pregnancy (73). The report said, "*these results are only suggestive of an effect, rather than being conclusive evidence of one*". Increased conduct problems were reported in 8–17-year-olds with the highest quartile of RF exposures (72) [page 250 (2)]. As studies suggested an effect on child development, the executive summary incorrectly stated, "*data on other non-cancer outcomes show no effects of RF field exposure*" [page 4 (2)].

For risks of brain tumours or acoustic neuromas in humans, "*the similar results of all investigators except the Hardell group, with no methodological inferiorities in these other investigators' studies overall, suggest that the results of the Hardell group are the problematic ones*" [page 308 (2)]. However, some significantly increased risks of brain tumours or acoustic neuromas were described in Hardell and non-Hardell studies [pages 282–306 (2), (91)], although non-Hardell significant data were omitted from the data tables and only mentioned in the text. For example, for gliomas with an ipsilateral mobile phone use of ≥ 1640 cumulative hours (ages 30–59), the international Interphone study reported a significant odds ratio (95% confidence interval) of 1.96 (1.22–3.16) and Hardell et al. reported a significant odds ratio of 2.32 (1.14–4.73) (91). Had the data tables included results for ipsilateral exposures, duration of use and more detail of the pooled Interphone studies, it would have been clearer that significantly increased risks had been reported. "*With no methodological inferiorities in these other investigators' studies*" was incorrect. The Interphone study did not take cordless phone use into account in the analysis for mobile phones (91); the Danish cohort study misclassified corporate mobile phone users as non-users, as well as those who took subscriptions out after 1995 (92).

The comment in the executive summary, "*the accumulating evidence on cancer risks, notably in relation to mobile phone use, is not definitive, but overall is increasingly in the direction of no material effect of exposure*" [page 4 (2)], was misleading. Significant risks were most common for ipsilateral exposures, latencies of 10 years or more since first use or the highest cumulative hours of use (2), (91). If anything, as use increased, the evidence increasingly pointed towards possible risks.

The executive summary stated for cells in vitro: "*In particular, there has been no convincing evidence that RF fields cause genetic damage or increase the likelihood of cells becoming malignant*" [page 3 (2)] and in the chapter on cellular studies: "*Results from studies using other cell types are also contradictory. Epithelial cells exposed to …*" [page 86 (2)]. However, all in vitro studies included on epithelial cells [four, one retracted, page 84 (2), (93–95)], from more than one laboratory, found damage to DNA or chromosomal aberrations in response to RF signals. Forty-six percent of genotoxicity studies identified as included in the report (36 out of 78; SI) described evidence for genotoxicity in response to RF fields, but at least 40 genotoxicity studies were omitted (SI). If these had been included, 52% (61 out of 118) of genotoxicity studies overall and 47% of in vitro (36 out of 76) would have described evidence for genotoxicity (SI; AGNIR restriction to the English language; identified from PubMed and EMF-Portal databases). AGNIR found the genotoxicity evidence unconvincing, but a more accurate conclusion could have been that RF signals appear to be genotoxic under certain circumstances, but not others.

For the immune system [page 174 (2)], a Russian study was included (96), which mostly replicated earlier Russian studies and a French one which did not (97). The conclusion was "*it is clear that the results of the original Soviet studies have not been confirmed*". It was not clear, as the report also referred to the Russian study with "*These results do not appear to be identical to the original, although they do show the same tendency. Results of ELISA reinforced this conclusion. Grigoriev and colleagues also reported that very few pregnant animals receiving serum from exposed animals gave birth to live animals (4 out of 12), which is also supportive of the previous results*".

The report described cognitive performance of RF-exposed and sham-exposed Alzheimer's disease-like transgenic mice (98) [pages 144–147 (2)]. However, there were no shams in the study, as controls were housed in a separate room without a Faraday cage; exposed mice (two 1 h exposures per day, 918 MHz, SAR 0.25 W/kg) were continuously housed within a Faraday cage for up to 9 months (98). Cognitive improvements in the exposed groups compared to controls may have been the result of long-term protection from environmental electromagnetic fields by the Faraday cage. Because background man-made electromagnetic fields may alter experimental results and are often present in experimental environments, they ought to be described in the Methods section for all biological studies, but are often omitted, as in this paper. The AGNIR report conclusions [page 318 (2)] described this as a well-performed study, whilst other effects of RF signals on cognition were dismissed as inconsistent. Varied responses might indicate dependency upon physiological or experimental conditions and do not automatically justify ignoring evidence.

Conclusions

Decisions about involuntary, continuous and widespread RF exposures in schools, hospitals, workplaces and public and private spaces in the UK and around the world have been made based upon inaccurate conclusions of the AGNIR report. Published in 2012, it continues to be used to justify RF exposures and dismiss concerns about possible adverse effects on health, well-being or development.

The denial of the existence of adverse effects of RF fields below ICNIRP guidelines in the AGNIR report conclusions is not supported by the scientific evidence. Studies have, as described as examples in this review, reported damage to male reproductive health, proteins and cellular membranes, increased oxidative stress, cell death and genotoxicity, altered electrical brain activity and cognition, increased behavioural problems in children and risks of some cancers. For future official RF reports, it is important to check that conclusions accurately reflect available evidence before decisions which impact on public health are made based on the executive summary and overall conclusions.

The involvement of ICNIRP scientists in the misleading report calls into question the basis and validity of the international exposure guidelines. To protect public health, we need accurate official assessments of whether there are adverse effects of RF signals below current international ICNIRP guidelines, independent of the group who set the guidelines.

The anticipated WHO Environmental Health Criteria Monograph on Radiofrequency Fields, due in 2017, is being prepared by a core group and additional experts (99), with 50% of those named, being, or having been, members of AGNIR or ICNIRP (Table 2). Considering the importance of the Monograph for worldwide public health and the inaccuracies described here, independence from AGNIR would increase confidence in the report findings. Independence from ICNIRP is necessary to remove the conflict of interest when effects below ICNIRP exposure guidelines are being assessed.

Schools, hospitals, employers, organisations and individuals have legal responsibilities to safeguard the health, safety, well-being and development of children, employees and members of the public. But they are unable to fulfil their legal responsibilities when they have been provided with inaccurate information and the evidence of possible harm has been covered up.

Individuals and organisations who/that have made decisions about the often compulsory exposures of others to wireless RF communication signals may be unaware of the physical harm that they may have caused, and may still be causing, because they have not been accurately informed of the risks. This has been a safeguarding failure and the health of some children or adults may have been damaged as a result. To prevent further possible harm, restrictions on exposures are required, particularly for children, pregnant women and individuals with medical conditions. All children in schools and care environments need protection from the potential harmful effects of RF exposures and not, as is now often the case, a compulsory use of wireless devices in the classroom. Children may unjustly face losing their human right to an education if they do not want to absorb RF fields every day at school and no alternative environments are available. Attention also needs to be given to the provision of safe working environments for employees and safe public spaces, particularly where exposures are involuntary.

PHE and AGNIR had a responsibility to provide accurate information about the safety of RF fields. Unfortunately, the report suffered from an incorrect and misleading executive summary and overall conclusions,

Table 2: Named contributors to the WHO Environmental Health Criteria Monograph on Radiofrequency Fields [(99), in preparation] and membership of ICNIRP or AGNIR.

Core group	
Feychting M.	Vice-Chair ICNIRP, AGNIR
Mann S.M.	ICNIRP, AGNIR
Oftedal G.	ICNIRP
van Rongen E.	Chair ICNIRP
Scarfi M.R.	
Zmirou D.	
Additional experts	
Aicardi G.	
Challis L.	Formerly AGNIR
Curcio G.	
Hug K.	
Juutilainen J.	ICNIRP
Lagorio S.	
Loughran S.	ICNIRP
Marino C.	ICNIRP
McNamee J.	
Naarala J.	
Peyman A.	AGNIR
Röösli M.	ICNIRP
Rubin G.J.	AGNIR
Schoemaker M.	
Selmaoui B.	
de Sèze R.	ICNIRP
Sienkiewicz Z.J.	ICNIRP, AGNIR
Simko M.	
Vijaylaxmi	
Zeni O.	

inaccurate statements, omissions and conflict of interest. Public health and the well-being of other species in the natural world cannot be protected when evidence of harm, no matter how inconvenient, is covered up.

Conflict of interest statement: The author states no conflict of interest.
Ethical approval: The conducted research is not related to either human or animal use.

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