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Documentation of inaccuracies, mischaracterizations and critical omissions in David Grimes' JAMA Oncology review of RFR and Cancer.

I.Section "Biophysical Overview"- Grimes Omits Research Reporting Genetic Effects from Non Ionizing Radiation

In the initial section of the paper, Grimes describes the difference between ionizing and non ionizing electromagnetic radiation explaining how the higher frequencies of ionizing radiation are energetic enough to directly break apart DNA strands. He then presents his opinion, the long held assumption that since RFR is non-ionizing, it cannot damage DNA nor lead to the genetic mutations necessary for cancer. This assumption is scientifically unsubstantiated.

Grimes omits the in vitro and in vivo experimental evidence reporting that RFR and non ionizing electromagnetic radiation can lead to genotoxic effects including DNA strand breaks, micronucleus formation, and chromosomal structural changes (Lai, 2021).

As an example of research omitted by Grimes, the National Toxicology Program (NTP) found significant increases in DNA damage from cell phone RFR at non thermal levels (Smith-Roe et al., 2020). Genetic damage is a key characteristic of cancer (Smith, 2020).

We note that Grimes states inaccurately in the "Discussion" section that "Prior reviews of evidence also do not support claims of genotoxic effects due to RFR." He then supports this statement with footnote 31 to an outdated review (Verschaeve, 2005) however this 2005 review is well superseded by the 2021 review of genetic effects (Lai, 2021) yet Grimes omitted this review.

I.Summary of Issues:

1. Grimes mischaracterizes RFR as not capable of damaging DNA and he should have referenced the latest published reviews in RFR and DNA damage indicating that in fact RFR is associated with DNA damage. Just because RFR is non-ionizing does not mean that it cannot cause, promote or play a role in the development of cancer.
2. Grimes should have referenced the NTP report of DNA damage.

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3. Grimes references an outdated review on genotoxicity to support his inaccurate conclusion. He should present more recent reviews, especially in light of the NTP genotoxicity results.

II. Section "Biophysical Overview"- Grimes Omits Research on Pathways RFR Can Lead to Cancer

Several pathways have been suggested to explain how non-ionizing RFR could lead to DNA damage and cancer. Grimes omits how, without causing direct DNA damage in the same way as ionizing radiation, RFR may lead to a cascade of events that initiate or promote tumor development (Barnes and Greenebaum 2018; Belpomme et. al., 2018; Blank and Goodman 2009, Markov et al., 2010).

RFR can interfere with oxidative repair mechanisms, induce oxidative stress, and impact cellular processes leading to cancer (Havas, 2016; Melnick, 2019; Yakymenko et al., 2016). A 2021 review reported the majority of the animal studies and more than half of the cell studies found increased oxidative stress caused by non ionizing electromagnetic fields and concluded that "a trend is emerging" that non ionizing EMF exposure, even in the low dose range, may well lead to changes in cellular oxidative balance (Schuermann et al., 2021). Induction of oxidative stress is a key characteristic of many human carcinogens (Smith et al., 2016). However, Grimes omits mention of oxidative stress.

Grimes inaccurately states there is a " lack of a plausible biophysical mechanism for carcinogen" for RFR. Low power RFR induces perturbations of Voltage Controlled Calcium Gates (VCCG) in cellular membranes which leads to imbalances in cytoplasmic ionic concentrations, leading to excessive reactive oxygen species (ROS) and DNA damage (Dasdag and Akdag, 2016; Panagopoulos, 2019; Panagopoulos et al., 2021). Yet this entire body of research is entirely missing from Grimes' review.

Grimes also omits reference to research considering real life exposures to EMF in combination with everyday toxic exposures. Animal studies have found tumor promoting effects when RFR is combined with a known carcinogen (Lerchl et al., 2015; Tillmann et al., 2010). Additionally, RFR can impact the integrity of the blood-brain barrier that protects the brain from toxic molecules circulating in the blood (Leszczynski et al., 2002; Salford et al., 2003; Sirav & Seyhan, 2011; Sırav & Seyhan, 2016; Tang et al., 2015).

II. Summary of Issues: Retraction needed

1. Grimes should have referenced publications that do exist on pathways and mechanisms by which non ionizing RFR can lead to DNA damage.
2. Grimes should have included the latest reviews on RFR and oxidative stress.
3. Grimes should have referenced publications finding RFR acts as a tumor promoter.

III. Section "Epidemiological Human Evidence"- Grimes misleadingly and inaccurately characterizes epidemiological human evidence without science based methodology, omitting numerous important research studies.

The section "Epidemiological Human Evidence" lacks scientific rhyme or reason. Grimes does not employ any methodology or systematic reasoning in his discussion of a few self selected studies. He highlights industry funded studies, misrepresents Interphone findings and puts forward unsubstantiated website statements.

Grimes conclusions are in sharp contrast to a recent comprehensive meta-analysis of case-control studies (Choi et al., 2020) which found significant evidence linking cellular phone use to increased tumor risk, especially among cell phone users with cumulative cell phone use of 1000 or more lifetime hours in their lifetime (which corresponds to about 17 min per day over 10 years), and especially among studies that employed high quality methods.

Grimes inaccurately presents the Interphone study which found elevated risk in long term cell phone users.

Grimes mischaracterizes the Interphone study stating that "no increase in risk of glioma or meningioma was observed." He omits that the Interphone study did, in fact, show "an association between glioma and acoustic neuroma and mobile-phone use; specifically in people with highest cumulative use of mobile phones, in people who had used mobile phones on the same side of the head as that on which their tumor developed, and in people whose tumor was in the temporal lobe of the brain (the area of the brain that is most exposed to RF radiation when a wireless phone is used at the ear)" as stated by the International Agency for Research on Cancer of the Interphone study (Cardis et al., 2011; IARC 2013, Interphone study group, 2010). He omits that analyses of a subset of five INTERPHONE study countries to investigate bias found stronger positive associations among long-term users and those with highest cumulative call time and number of calls (Turner et al., 2016).

Grimes inaccurately presents the findings of the CERENAT case-control study.

Grimes states “Aside from these large studies, several smaller epidemiological studies have been performed,11-15 which have to date not found any link between cancer incidence and cell phone usage.” He then goes on to state the one exception is Dr. Lennart Hardell 2011 pooled analysis. This is false. Grimes’ footnote 13 refers to Coureu 2014 which found a statistically significant positive association in the heaviest users when considering life-long cumulative duration of more than 896 hours The authors conclude that these results support other findings concerning a possible association between heavy mobile phone use and brain tumors. Thus, Grimes misrepresents the CERENAT as proof of no association. He should have referenced it as evidence positive for an association.

Grimes cherrypicks highly criticized and industry funded studies.

Grimes highlights the Danish Cohort study which was initially designed with financial support by two Danish telecom operating companies TeleDenmark Mobil (partially owned by SBC Communications, which is Denmark’s largest phone company) and Sonafon (Hardell et al., 2007; Johansen et al., 2001). Grimes omits that the study design was highly criticized for serious limitations related to its flawed exposure assessment which allowed, for example, corporate users- who would have been some of the heaviest users- to be included in the unexposed group. Grimes omits that the Danish Cohort findings were highly criticized and deemed unreliable (Ahlbom et al., 2007; Davis et al., 2011; Frey, 2011; Kundi, 2012; Leszczynski, 2011; Morgan, 2011; Söderqvist et al., 2012).

Grimes also references the UK Million Women cohort study and omits the criticisms. This study was primarily designed for evaluating risks for hormone therapy not cell phone use. The researchers did not gather numerical data on cell phone usage per day or week. Instead participants were asked only two questions in 1990 and 2005 about their cell phone use: “How often do you use a cellphone?” and given three options to respond: ‘never’, ‘less than once a day’, ‘every day’; and “How long have you used it?” and participants provided total years of use (Benson et al., 2013). The study has been well criticized for its crude exposure assessment because women who spent merely a few minutes almost every day at baseline would be lumped together with women who used their phone one half hour or more per day (Moskowitz, 2013). However Grimes highlights the Million Woman study and Danish cohort studies as evidence of no link and omits their shortcomings and published criticisms.

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Grimes concludes by asserting unsubstantiated statements from an outdated website page of the World Health Organization.

Grimes misrepresents the stance of the World Health Organization by not differentiating between the WHO EMF Project with the WHO International Agency for Research on Cancer (IARC), two very distinct entities under the umbrella of the WHO. Grimes concludes his epidemiology section by quoting an October 2014 WHO EMF Project webpage which states "to date, no adverse health effects have been established as being caused by mobile phone use" (WHO, 2014). Readership may not be aware that the WHO EMF Project has not completed a science based review to issue such a conclusion on its website. The fact is that the WHO EMF Project's last health risk assessment on RFR was *in 1993* (*Electromagnetic Fields (EHC 137, 1992)*, 1993; *Health Risk Assessment*, n.d.).

Thus, the Grimes' WHO quote of "no adverse effects" does not rest on an up to date published scientific research review.

Fact: The WHO has two entities that address RFR- the EMF Project and the IARC. JAMA readership may be unaware of documented long standing industry ties and conflicts of interest in the WHO EMF Project (Hardell, 2017). After serious transparency issues halted an earlier attempt by the WHO EMF Project to review the RFR, the WHO EMF Project now has a renewed call for scientists (*Call for Experts*, 2021) to perform systematic reviews regarding RFR and cancer, however as of the date of this document, none have been completed.

However, Grimes misleadingly uses the WHO EMF Project's outdated website quote to conclude his section on human evidence. Grimes does not differentiate between the two distinct entities nor does he mention that the last RFR review by the WHO EMF Project was nearly three decades ago in 1993.

JAMA readership deserves more reference to a website page by an entity that has not reviewed the research since 1993.

While commenting on trends for central nervous system cancers to support his claim of no increased incidence, Grimes forgot to mention the study by Philips et al., 2018 that reported a doubling in incidence of glioblastoma (frontal and temporal lobes) in England between 1995 and 2015.

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III. Summary of Issues: Retraction needed

1. Grimes should accurately present the findings of the Interphone study which found elevated risk in long term cell phone users.
2. Grimes should accurately present the findings of the CERENAT study which found elevated risk in the heaviest users with longest duration of use.
3. Grimes should present the published criticisms of the Danish cohort study and inform readers of the industry financing to the study design.
4. Grimes should inform readers of the crude exposure assessment of the UK million woman study.
5. Grimes should utilize science based methodology regarding which studies to present in his “review”.
6. Grimes should inform JAMA readership of the difference between the WHO EMF project and the IARC and the published papers on conflicts of interest at the EMF Project.
7. Grimes should clarify that the WHO quote he references is from a 2014 website page and that the WHO EMF Project (who wrote the website page) has not undertaken a research review or a health risk assessment on RFR since 1993.
8. Grimes should inform readership that the WHO EMF Project is a different entity than the WHO International Agency for Research on Cancer
9. Grimes should clarify that WHO EMF project is planning for systematic reviews but none of these are not completed and thus the WHO EMF Project website statements rest on zero published systematic reviews of the evidence by the entity.
10. Grimes should reference the latest published systematic reviews on human evidence such as Choi et al., 2020 which confirm associations between RFR and tumors.
11. While commenting on trends for central nervous system cancers to support his claim of no increased incidence, Grimes should mention the study by Philips et al., 2018.

IV. Section In Vivo Experimental Data- Grimes inaccurately characterizes and downplays the National Toxicology Program animal study, and also omits other relevant animal research.

Grimes’ brief discussion on animal studies inaccurately describes and misleadingly dismisses the reports of the National Toxicology Program (NTP) animal carcinogenicity studies.

Grimes presented the NTP findings as only "ostensibly observed increased cancer rates in rats." However, not only did the study find significantly increased incidences and/or trends for gliomas and glial cell hyperplasias in the brain and schwannomas and Schwann cell hyperplasias in the heart of exposed male rats, but they also found significantly increased DNA damage (strand breaks) in the frontal cortex of the brain in male mice, the blood cells of female mice, and the hippocampus of male rats (Smith-Roe et al., 2020) as well as reduced pup birth weights and the induction of cardiomyopathy of the right ventricle in both male and female rats. The increases in schwannomas were deemed "clear evidence" of the ability of the exposure to cause cancer in laboratory animals.

Melnick 2019 explains that the NTP study was designed to test the hypothesis that cell phone radiation at non-thermal levels could not cause adverse health effects. However, the study findings of the induction of tumors and hyperplasias in the brain and heart by RFR in the carefully controlled animal models of the NTP disproved this hypothesis. RFR at non thermal levels can cause cancer in animals. Melnick concludes that, "The overall results from the NTP studies indicate that cell phone RFR is potentially carcinogenic to multiple organs of exposed people."

Grimes presents criticisms of the NTP found to be scientifically "unfounded" criticisms by U.S. NTP scientists.

Grimes further dismisses the NTP findings stating it has been "roundly criticized for low-power and questionable methods" and he cites an FDA literature review and ICNIRP. However Grimes neglects to reference two published articles that directly address these criticisms and finds them factually unfounded (Melnick, 2019; 2020).

Longtime NIH scientist Ronald Melnick PhD published "ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields" in Health Physics focused on "correcting ICNIRP's false claims about the methodology, interpretation, and relevance of the National Toxicology Program studies." He responds to each criticism put forward by ICNIRP one by one. He concludes, "ICNIRP's misrepresentation of the methodology and interpretation of the NTP studies on cell phone RF radiation does not support their conclusion that "limitations preclude drawing conclusions about carcinogenicity in relation to RF EMFs…If ICNIRP's goal is truly aimed at protecting the public from potential harm, then it would be appropriate for this group to quantify the health risks associated with exposure to RF-EMFs and then develop health-protective guidelines for chronic exposures, especially for children, who are likely to be more susceptible than adults to

adverse effects of RF radiation. At the very least, ICNIRP should promote precautionary advice for the general public rather than trying to justify their decision to dismiss findings of adverse health effects caused by RF-EMFs and thereby retain their 20+ y-old exposure guidelines that are based on protection against thermal effects from acute exposures."

Furthermore, NTP senior scientist Dr. John Bucher responded specifically to this criticism early on in 2016 when the findings of tumors in the head and heart were first released in a report of the partial findings (See page 70 and 87 of Wyde et al., 2018). In his response, Bucher referenced several publications clarifying that while the NTP study design did indeed have low power, this does not correspond to high risk of false positive findings in properly constructed tests such as the NTP studies, especially with rare tumors. Just as Melnick 2018 explains, Bucher states that "with low statistical power, false negatives are much more likely than false positives." Yet Grimes entirely omits the scientific response of these expert US toxicologists.

In regards to the FDA literature review, Melnick not only published a response to each of the FDA criticisms one by one in his article "Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects" (Melnick 2019), but in addition, he also directly wrote the FDA a description of the inaccurate information in their 2018 Literature Review (Melnick, 2020).

In his letter he calls for a retraction of the FDA literature review that Grimes references because of what Melnick's documents as "major incorrect statements and omissions of relevant data." Melnick provides several examples including factual errors such as misstating the results of the genetic toxicology tests- an error that Grimes also makes. Melnick concludes with a strong statement that, "Based on the FDA review, which is not a risk analysis as stated in the document, the message for the general public appears to be that precautionary measures for use of cell phones are not necessary in spite of the fact that numerous studies have provided compelling evidence of increased cancer risk associated with exposure to cell phone RFR. This is an irresponsible message for a government agency that claims its mission is to protect consumers and promote public health."

Grimes inaccurately refers to the NTP as a preprint.

Grimes also inaccurately referred to the NTP study as a "preprint." While it is true that a 2016 preprint (NTP 2016) was released on the increased heart and brain tumors, final reports of all findings were released in 2018 (NTP, 2018a; 2018b) after an unprecedented three day peer review. In addition to elevated tumors, the final NTP final reports also document the induction of cardiomyopathy of the right ventricle in male and female rats. Grimes omits any direct citations to the actual NTP publications in his "review." He also omits the NTP findings of DNA damage published in 2020 (Smith Roe et al., 2020) and the other publications related to the elaborate study exposure system (Gong et al., 2017; Capstick et al., 2017).

Grimes omits subsequent publications analyzing the NTP findings and concluding that RFR now meets criteria to be designated by the WHO IARC as at least a probable carcinogen or in fact- a human carcinogen.

Several scientists, several of whom notably served on the WHO/IARC EMF working group in 2011, reviewed the findings of the NTP as well as other recent studies and now conclude the evidence is adequate for the International Agency for Research to conclude that cell phone radiation is a probable carcinogen and even a proven Group 1 human carcinogen (Miller et al., 2018; Peleg et al., 2018; Carlberg and Hardell 2017; Belpomme et al., 2018; Melnick, 2019; Portier, 2021; Lin, 2019; Directorate-General for Parliamentary Research Services (European Parliament) & Belpoggi, 2021).

Hardell and Carlberg 2018 comments that the NTP findings allow the following conclusion "there is clear evidence that RF radiation is a human carcinogen, causing glioma and vestibular schwannoma (acoustic neuroma). There is some evidence of an increased risk of developing thyroid cancer, and clear evidence that RF radiation is a multi-site carcinogen. Based on the Preamble to the IARC Monographs, RF radiation should be classified as carcinogenic to humans, Group 1."

Vornoli et al., 2019 reviews the in vivo mammalian studies and concludes that "there is now clear evidence that RFR causes cancer in experimental animals…There is also stronger evidence that RFR exposure is responsible for causing alteration of various sperm parameters, thus, affecting male fertility. Although a clear quantification of the carcinogenic and reproductive risk is still lacking, these animal findings suggest that a precautionary approach should be promoted by regulatory and health agencies, especially for children and pregnant women." (Uche & Naidenko, 2021) analyzed the NTP data according to current risk assessment guidelines and concluded thatU.S. government FCC limits should be strengthened by 200 to 400 times to protect children. Yet Grimes omits these publications.

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IV. Summary of Issues: Retraction needed

1. Grimes should have included the full results of the NTP study (tumors in various sites deemed “clear evidence” as well as DNA damage and cardiomyopathy).
2. Grimes should not refer to the NTP as a “preprint” but as final reports.
3. Grimes should have citations to the actual NTP reports and publications including the 2020 report of DNA damage.
4. Grimes should have clarified that the tumor types found in the NTP study were also found in the Ramazzini animal study which used much lower exposures to mimic cell tower exposures.
5. Grimes should have explained to readers that the rare types of tumors found in these two large scale animal studies were similar types of tumors found in epidemiological studies of long term cell phone users. Several publications conclude that the concordance between rats and humans in tumor type strengthens the animal-to-human association. Grimes should have presented these studies.
6. Grimes should have referenced the publications analyzing the NTP data concluding that RFR meets criteria to be classified as a human carcinogen by IARC and that regulations need to be strengthened.
7. Grimes should have referenced Melnick's response to the criticisms of the NTP by the FDA and ICNIRP.
8. Grimes should have specifically referenced the numerous responses of NTP scientists to the specific criticism that the NTP study was “low power” as “false negatives are much more likely than false positives.”

V. Section “In Vivo Experimental Data”- Grimes references ICNIRP publications to downplay the importance of NTP but neglects to reference the publications on ICNIRP’s conflicts.

Grimes gives heavy weight to a criticism of the NTP studies by the International Commission for Non-ionizing Radiation (ICNIRP) in his discussion of experimental data (see Grimes’ footnote 26). He also later references a communication penned by Martin Roosli, ICNIRP Commissioner as will be discussed in number 6 of this call for retraction. However Grimes neglects to share the numerous publications criticizing the small 14 member ICNIRP for conflicts of interest.

Former ICNIRP member James C. Lin published Science, Politics, and Groupthink (Lin, 2021) referring to ICNIRP as a "privately constituted group, with self-appointed membership" that has dismissed and criticized the positive results of two " well-conducted RF exposure studies [referring to the NTP and Ramazzini animal studies]" which showed consistent results of significantly increased cancer risks from mobile phone exposures." He concludes that, "when confronted with such divergent assessments of science, the ALARA—as low as reasonably achievable—practice and principle should be followed for RF health and safety."

"Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 Guidelines on Radiofrequency Radiation" (Hardell et al., 2021) documents the misleading and incorrect statements made by ICNIRP. In this article the authors document how the ICNIRP conclusions are not objective and lack scientific credibility according to a research report that investigated ICNIRP commissioned by two European Parliament Members published in June 2020 entitled "The International Commission on Non-Ionizing Radiation Protection: Conflicts of Interest, Corporate Capture and the Push for 5G" (Buchner & Rivasi, 2020).

As detailed by Hardell 2017 the biophysicist Michael Repacholi was the first chairman of ICNIRP in 1992 and is still Member Emeritus. He also founded the WHO EMF Project of the World Health Organization via wireless industry funds which were funneled through a hospital- a fact not made public for years. "Michael Repacholi immediately set up a close collaboration between WHO and ICNIRP (being head of both organizations) inviting the electric, telecom and military industries to meetings. He also arranged for a large part of the WHO EMF project to be financed by the telecommunication industry's lobbying organizations; GSM Association and Mobile Manufacturers Forum, now called Mobile & Wireless Forum (MWF)."

Hardell and Carlberg also published "Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest" (Hardell & Carlberg, 2020) detailing how the independent evaluations of RF radiation health risks are ignored by ICNIRP and other closely connected groups. They conclude that, " there seems to be a cartel of individuals monopolizing evaluation committees, thus reinforcing the no-risk paradigm. We believe that this activity should qualify as scientific misconduct."

Investigate Europe published a series of investigations on the issue and determined that the ICNIRP and the EMF Project are a "close knit" "small circle of insiders who reject

alarming research" ("5G: Big Promises, unknown risks," 2019; Investigate Europe, 2019).

As detailed earlier in this critique, longtime NIH scientist Ronald Melnick PhD published "ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields" (Melnick, 2020) in Health Physics focused on correcting ICNIRP's "false claims" and "misinformation" in the ICNIRP critique that "aim to undermine the utility of the NTP studies for assessing human health risks."

Belpomme et al., 2021 states, "contrary to the scientifically unfounded statement of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a non-governmental German organization with supposed close links with the industry, the physical and biological data obtained from these experimental studies strongly suggest that non-thermal (or microthermal) health effects can be caused in animals as well as in humans by low intensity non-ionizing radiation."

V. Summary of Issues: Retraction needed

1. Grimes does not inform readers of the numerous critiques, long history of industry ties and conflicts of ICNIRP.
2. Grimes should clarify that ICNIRP has only up to 14 members and it is an invite only private group with no oversight.

VI. Section "Discussion"- Grimes mischaracterizes the determination and stance of the International Agency for Research on Cancer (IARC).

Grimes misleadingly downplays the IARC designation of RFR as a group 2B agent (a possible carcinogen) in 2011, omits the reasoning for the determination and and omits that the IARC advisory group has recommended a reevaluation as "high priority" citing to recent research strengthening the association.

Grimes omits that the IARC designation was based on evidence associating RFR with tumors.

Grimes omits that the 2011 WHO/IARC conclusion that RFR was a Group 2B "possible" carcinogen was largely based on human studies that found long term cell phone users had increased risk for tumors- glioblastomas and acoustic neuromas (WHO/ IARC 2011). The scientific documentation for the determination was compiled in a 2013 monograph (IARC 2013). At that time there was limited animal evidence demonstrating

carcinogenicity and this is one of the reasons the designation was not stronger. However, since that date, two large scale animal studies have found increased tumors demonstrating carcinogenicity in laboratory animals exposed to both near field (cell phone) and far field (cell tower) exposures (Falconi, 2018; NTP, 2018). The tumor types found in the recent animal studies, glioma and schwannoma, are similar to those associated with the use of wireless phones, glioma and acoustic neuroma (vestibular schwannoma), in human epidemiological studies (Hardell, 2018). Yet Grimes omits this entirely.

Grimes omits that the WHO advisory group has recommended a re-evaluation for RFR.

Furthermore, Grimes omits that the WHO/IARC advisory group recommended RFR be re-evaluated as a "high priority" within 5 years due - largely in part- to the recent animal research findings positive for cancer (IARC, 2019). IARC has not reviewed the research since 2011.

Grimes downplays the IARC designation by misleadingly quoting a short Chapter penned by a scientist connected to ICNIRP- an organization with documented conflicts of interest.

Grimes states the designation is "also frequently misunderstood as implying evidence of harm" and then he goes on to quote a 2020 IARC communication (Wild et al., 2020) that seems dismissive of recent evidence. However the 2020 "WHO communication" Grimes refers to is not a systematic review but is instead a short Chapter containing only two pages dedicated to studies on non-ionizing radiation written by two people. One of the authors is a Commissioner of ICNIRP, an organization documented to have long standing industry ties. The other author has expertise in *ionizing* radiation, not *non-ionizing* radiation.

The Chapter Grimes refers to as a "WHO communication" is not a systematic review and only briefly refers to self selected epidemiological studies- and not the animal or cell studies. Grimes misleadingly places a quote from this article after the IARC designation. Some JAMA readership will most likely inaccurately believe that the 2020 WHO communication is an updated conclusion or stance by independent IARC experts who have evaluated the totality of the science transparently.

VI. Summary of Issues: Retraction needed.

1. Grimes should have summarized the data on associations between cell phone use and tumors which substantiated the 2011 IARC designation.

2. Grimes should not have followed the IARC designation with a Chapter by an ICNIRP scientist as it will mislead the reader. If Grimes must keep this article in then he should clarify this "communication" is a short two page description of self selected studies and is not a systematic review nor official stance of the WHO or IARC.
3. Grimes should clarify that the IARC has not reviewed the science on RFR since 2011 and he should inform readers that the WHO advisory group has recommended a re-evaluation of RFR due to the animal studies showing increased tumors of the very same type as found in studies of cell phone users.

VII. Section: "Summary of Recent Conclusions by Public Health Bodies Worldwide"- Grimes cherry picks conclusions omitting numerous public health conclusions to reduce cell phone exposure.

Grimes inaccurately asserts there is a "scientific consensus" on RFR and then presents as proof a self selected short list of entities in a table he entitles "Summary of Recent Conclusions by Public Health Bodies Worldwide." Grimes omits that many public health bodies recommend reducing RFR exposure.

Grimes describes the table as a "non-exhaustive list of current scientific consensus for carcinogenicity from RFR by major public health bodies. Readership will likely assume the consensus is that safety is assured. In reality the stance of public health bodies is far more complex and nuanced. Some public health bodies refer to ICNIRP's conclusions but many others have decided to enact more protective policies. While many countries with these precautionary policies do not necessarily opine that RFRs are "proven" to cause cancer, they instead acknowledge the research gaps, the long latencies for cancers and the vulnerability of children and the fetus.

A small sampling of examples of conclusions by public health bodies omitted by Grimes.

- *Numerous countries have decided to set RF exposure limits and regulatory schemes for cell tower networks far more stringent than the FCC and ICNIRP*. These countries include China, Russia, Canada, Israel, Turkey, Bulgaria, Brussels Belgium, Chile, Belarus, Serbia, Slovenia, Croatia, Montenegro, Italy, Switzerland, Greece, India, Liechtenstein, Tajikistan, Kazakhstan, Kyrgyzstan, Ukraine, Kuwait, Grand Duchy of Luxembourg, Bosnia Herzegovina,Georgia, Uzbekistan and Republic of Moldova (ITU-D Study Group 2, 2017; Madjar, 2016; Redmayne, 2016; Repacholi et al., 2012).

- Over a dozen public health bodies of various governments have issued recommendations on their websites or educational materials and brochures that the public and/or children should reduce exposure to their brain by keeping the phone away from their head. The recommendations do not say “if you are worried” but instead clearly recommend reducing exposure. (A full list with direct links to sources can be found at Environmental Health Trust (EHT, 2021)).
    - “Experts – including those on the Superior Health Council – advise everyone to limit their exposure to mobile phone radiation states the Health Food Environment Agency of Belgium (Belgian Federal Government, 2016)
    - “Advice from the Chief Medical Officer on mobile phone use: We may not truly understand the health effects of mobile phones for many years. However, research does show that using mobile phones affects brain activity. There is general consensus that children are more vulnerable to radiation from mobile phones than adults. Therefore the sensible thing to do is to adopt a precautionary approach rather than wait to have the risks confirmed.In the light of these findings, the Chief Medical Officer of the Department of Health and Children strongly advises that children and young people who do use mobile phones, should be encouraged to use mobile phones for “essential purposes only (Government of Ireland Department of Health, 2019).
- U.S. Public health authorities have issued recommendations. The California Department of Health released an advisory on how to reduce cell phone radiation stating, "Parents should consider reducing the time their children use cell phones and encourage them to turn the devices off at night” (California Department of Public Health, 2021) and (California Department of Public Health, 2017). The Connecticut Department of Public Health states it is “wise” to reduce RFR to one’s brain (Connecticut Department of Public Health, 2015). The North Carolina Public Health Department’s Occupational health Department lists the full cancer findings of the NTP study, the FDA stance and also the American Academy of Pediatrics recommendations to reduce cell phone radiation stating “there is some concern that exposure to non-ionizing radiation, also called radio frequency radiation, that is emitted by cell phones may result in an increased risk of cancer or other health effects” (North Carolina Department of Health and Human Services, 2020). The Maryland State Children’s Environmental Health And Protection Advisory Council, whose 19 member Commission includes experts in public health issued a report recommending reducing RFR to children in schools (Environmental Health Trust Posted Friday, 2017). Yet Grimes omits these.

- Several countries have laws in place to reduce exposure, in addition to their public health campaigns. For example France, Belgium, and French Polynesia have bans on mobile phone ads targeted to children and bans on the sale of phones designed for children. Several countries limit Wi-Fi RFR in classrooms including France, Israel, French Polynesia and Cyprus (Environmental Health Trust, n.d.). Grimes omits these.
- As an example of a public health authority policy clearly based on a conclusion that safety is not assured, a 2019 Order of the Minister for Solidarity and Health and the Minister for the Economy and Finance, stated consumers should be informed to; France informs consumers that they should use a hands-free or speakerphone, limit frequency and duration of calls for children, "keep away from the belly of pregnant women, Keep away from the lower abdomen of adolescents" (Order of 15 November 2019 Relating to the Display of the Specific Absorption Rate of Radio Equipment and to Consumer Information, 2019). Several other countries have laws and orders in place to inform consumers about the RFR from the device and educate the public to reduce exposure, however Grimes omits all of these conclusions by public health bodies.

In contrast to Grimes conclusions, the European Parliament European Parliamentary Research Service Report "Health Impact of 5G" released in July 2021, concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns. Hundreds of scientists are warning that current laws do not protect people and wildlife from RFR and non -ionizing radiation. (Hardell and Nyberg, 2020, Kelley et al., 2015; Mallery-Blythe, 2020)

Grimes inaccurately presents ICNIRP as "a public health body."

ICNIRP is inaccurately presented as a public health body and does not meet the definition of a public health body. According to US Health and Human Services a "public health authority" "is an agency or authority of the United States government, a State, a territory, a political subdivision of a State or territory, or Indian tribe that is responsible for public health matters as part of its official mandate, as well as a person or entity acting under a grant of authority from, or under a contract with, a public health agency" (Office for Civil Rights (OCR), 2008).

If ICNIRP is a public health body (which we have no documentation that it is) then of what entity or government is ICNIRP "a body"? The entire world? Lengthy discussions on the conflicts of interest are referenced in criticism 5 and will not be repeated in this

section. However, as referenced in that section, the 14 member ICNIRP has no oversight by any entity or country.

While the name may sound very authoritative, the reality is that ICNIRP created itself with industry funds and it's recommended exposure limits have remained largely unchanged for over two decades. ICNIRP limits are based on protection from behavioral disruption and overheating- short term effects- and the studies used to set their thresholds are decades old and involve a handful of animal studies. ICNIRP does not believe adverse effects from long term effects exist so long as the RFR is at non-thermal levels.

Grimes omits the WHO, a specialized agency of the United Nations responsible for international public health, from his table of conclusions. He could have cited the WHO IARC 2011 conclusion and also could have referenced the 2019 recommendations of the advisory group.

VII. Summary of Issues: Retraction needed

1. Grimes falsely misrepresents that there is "scientific consensus." He should present the EMF Scientist Appeal and the conclusions of hundreds of scientists who believe that RFR can cause adverse effects at low levels instead of presenting that there is "consensus."
2. Grimes should present the opinion of the California, North Carolina and Connecticut Departments of Health which recommend reducing exposures in light of the need for more research.
3. Grimes should present how some countries have awareness campaigns and laws to minimize children's RFR exposures as well present reports such as the European Parliament "Health Impact of 5G" released in July 2021, concluding that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans.
4. Grimes should have included the WHO IARC determination of RFR as a possible carcinogen and the 2019 advisory group recommendations in his table of "public health body" opinions.

VIII. Grimes omitted numerous studies that provide evidence for RFR carcinogenicity

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We do not have time to detail every study and issue area omitted by Grimes but here are a few examples of omitted research studies.

- **Thyroid Cancer**: A Yale study supported by the American Cancer Society that found an association between thyroid cancer in cell phone users with a type of genetic variation result suggests that genetic susceptibilities modify the associations between cell phone use and risk of thyroid cancer - a cancer with incidence in the U. S. nearly tripled since the 1980's (Luo et al., 2020). Carlberg et al., 2020 found Swedish Cancer Registry trends in agreement with the postulation that RFR is a causative factor for thyroid cancer. A review by researchers of the California Institute of Behavioral Neurosciences & Psychology on thyroid hormones and thyroid gland histopathology found evidence that GSM RFR could be associated with alterations in T3, T4, and TSH serum hormone levels, lead to thyroid insufficiency as well as hyperstimulation of thyroid gland follicles supporting earlier analysis (Alkayyali et al., 2021;Asl et al., 2019; Di Ciaula et al., 2021)
- **Breast Cancer:** A 2020 case control study that found women who carry cellphones in their bra, near their chest and abdominal area have elevated breast cancer risk (Shih et al., 2020) A 2013 publication on case reports of four young women with no family history/known risk factors of breast cancer, negative for BRCA1 and BRCA2 —ages from 21 to 39—with multifocal invasive breast cancer who regularly carried their smartphones in their bra developed unusual tumors in areas of their breasts immediately underlying the phones (West et al., 2013).
- **Epidemiology:** Grimes misrepresents studies in the section on epidemiology stating that there has been no associations to tumors with the one "exception" being a pooled Swedish analysis referencing (Hardell, 2011). Grimes omits that there have, in fact, been several subsequent publications documenting associations between wireless phone use and tumors (Hardell et al., 2013; Hardell & Carlberg, 2015; Sadesky et al., 2008) as well as associations with decreased survival of glioma patients (Carlberg and Hardell, 2014). Although Grimes briefly and opaquely refers to the existence of additional publications of Swedish data later in the discussion section stating "the FDA noted these results included variously unjustified assumptions, questionable data methods, and interpretation bias, noting that "increased risk trends that stemmed from multiple publications by the same group (Hardell and Carlberg, 2009-2017, Sweden) were likely affected by limitations of a single data source limited to one population" he only links to the FDA literature review.
- Thus, not only does Grimes misrepresent the Interphone and CERENAT study as mentioned earlier, but also he fully omits mention of studies on other tumor types

such as breast cancer, thyroid cancer and parotid gland tumors. Readership not familiar with the science would not have the information to understand that there are, in fact, numerous studies finding associations between RFR exposure and tumor development.

VIII. Summary of Issues- Retraction needed.

1. Grimes omits research associating RFR with thyroid cancer and these studies should be included.
2. Grimes omits research associating RFR with breast cancer and these studies should be included.
3. Grimes misrepresents the state of epidemiology as if there were just one study that found an association to cancer when in fact there have been several publications documenting associations between wireless phone use and tumors.

VIIII. Section "Discussion"- Grimes mischaracterizes state of science regarding RFR and Bradford Hill criteria.

Grimes states without reference "nor does any ostensible animal or epidemiological evidence come close to meeting Bradford Hill criteria or similar for causation" but he omits publications which conclude that Bradford Hill criteria is met (Carlberg and Hardell 2017, Peleg et al 2018).

Professor Lennart Hardell presented his conclusion that RFR met Bradford criteria in a lecture entitled "Using the Bradford Hill viewpoints to evaluate the evidence on RF radiations from mobile phones to head tumors lecture"(Royal Society of Medicine, 2019) and a meeting 'Association or causation in miasmas and mixtures: current reflections on Bradford Hill's 1965 contribution to public health' at the Royal Society of Medicine in London organized by the Epidemiology & Public Health Section, Brunel University London in October 2016.

VIIII. Summary of Issues- Retraction needed.

1. Grimes should reference publications that conclude Bradford Hill criteria are met for RFR instead of inaccurately stating that there is no evidence coming close to meeting Bradford Hill criteria.

IX. Section: "Discussion"- Grimes inaccurately asserts unsubstantiated attacks against the Bioinitiative referencing his own publications.

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Grimes attacks the Bioinitive with unfounded accusations referencing two papers he himself wrote as proof, despite the fact that in his papers Grimes asserts misleading and inaccurate information and his claims are unfounded.

In the JAMA article Grimes describes the Bioinitiative Report as "non scholarly" which "despite its popularity, has been repeatedly debunked by health bodies worldwide (30), and the attempts to treat its unsubstantiated assertions as equivalent to the weight of peer-reviewed weight of scientific evidence are archetypical false balance (33)."

- Footnote 30 is Grimes 2017 which itself has numerous inaccurate statements and references only 4 "health" bodies - 2 of which are industry tied and all of which are not even referencing the current Bioinitiative Report.
- Footnote 33 references Grimes 2019 which is irrelevant because the calls for stronger regulations are based on actual peer reviewed publications so his argument is invalid.

To start, Grimes inaccurately calls the BioInitiative Report a "a non scholarly work" despite the fact that:

- After it was first published, the content of the Bioinitiative Report underwent peer review and was published in condensed form as a special two-volume issue published in a special issue of the journal Pathophysiology ("Electromagnetic Fields (EMF) Special Issue," 2009). A summary " Biological effects from electromagnetic field exposure and public exposure standards" was published in Biomedicine & Pharmacotherapy in 2008 (Hardell and Sage 2008) and many of the later Chapters have been, in fact, published in the peer reviewed literature (Herbert and Sage 2013a, 2013b).
- The Bioinitiative Report is written by 29 scientists, researchers, and public health policy professionals reviewing the published peer reviewed research from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS. At the time of the 2012 Bioinitiative report, experts included Gerd Oberfeld, MD Public Health Department, Salzburg, Austria; David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, New York; Prof. Leif Salford, MD, PhD, Professor and Chairman, Department of Neurosurgery, Lund University Hospital Lund, Sweden; Prof. Henry Lai, PhD (emeritus) Department of Bioengineering, University of Washington, Seattle, Washington; Prof. Lennart Hardell, MD, PhD, Department of Oncology, Orebro University Hospital, Orebro, Sweden USA among others (link).

- The Bioinitiative Report cites thousands of peer-reviewed papers, many in the highest quality journals.

Note: in order to fully elucidate the misleading information, we now address the JAMA article as well as Grimes's references of his own papers.

Grimes states that the BIR has been "repeatedly debunked by health bodies" and footnotes Grimes, 2017), however in this paper there are just 4 well outdated statements by entities which are not all "health bodies." Further two are industry funded or composed of industry funded persons.

We detail the issues with the 4 entities referenced by Grimes:

A 2008 "Position Statement" of the Australian Center for Radiofrequency BioEffects (Croft et al., 2008) - an entity which was established and funded by the Wireless company Telstra as stated on the Telstra website (*Telstra - EME Research and Science Monitoring - Consumer Advice*, n.d.). This position statement was again not peer reviewed and not relevant to the 2012 Bioinitiative Report. Take, for example, one of the authors Ray McKenzie who's linked-in page states he worked as EMF scientific advisor for Telstra 1995 to 2011 (*Ray McKenzie - EME Specialist Consultant - Self-Employed | LinkedIn*, n.d.). He later worked as a manager at the Mobile Carriers Forum which is a special division of the Australian Mobile Telecommunications Association. Grimes should note the industry financing of the authorship of this statement.

A 2009 Statement by COMAR, a technical Committee of the Engineering in Medicine and Biology Society of the Institute of Electrical and Electronics Engineers (Radiation (COMAR), 2009) is not a public health body but in fact a group of mostly engineers, physicists and telecommunications workers. For decades, the leadership has been comprised of numerous individuals financially supported by wireless companies and its meetings, are usually held in association with meetings of the IEEE International Committee on Electromagnetic Safety (ICES) as its membership is made up mostly of ICES members (International Committee on Electromagnetic Safety, 2011). As just one example, Life fellow CK Chou was former Chief Motorola scientist and COMAR meetings sometimes were convened at Motorola Solutions along with many of the ICES subcommittees (See 2010 meeting at Motorola **https://www.ices-emfsafety.org/wp-content/uploads/2014/11/TC95_Minutes_201012.pdf)** Grimes should note the industry ties.

A 2008 Health Council of Netherlands statement-which is not peer reviewed nor published and is out of date and not relevant to the current Bioinitiative Report. It is notable that subsequent reports of the Health Council of the Netherlands conclude that reducing exposures makes sense. For example, their 2016 and 2020 reports recommends "the ALARA principle to exposure to RF EMF, meaning that exposures should be As Low As Reasonably Achievable" (https://www.healthcouncil.nl/documents/advisory-reports/2016/06/01/mobile-phones-and-cancer-part-3-update-and-overall-conclusions-from-epidemiological-and-animal-studies, and https://www.healthcouncil.nl/documents/advisory-reports/2020/09/02/5g-and-health).

A 2009 Statement by EU EMF-NET Report: Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)- again outdated and well superseded by subsequent reports.

Grimes should clarify the statement he cites is well outdated.

In 2011, the European Parliament and its member countries unanimously adopted a resolution to address public health risks from EMF and wireless technologies entitled Resolution 1815: The potential dangers of electromagnetic fields and their effect on the environment. The European Parliament Report Report for the Resolution (https://pace.coe.int/en/files/13137/html) states: *"The representative of the European Environment Agency in Copenhagen, an official advisory body to the European Union, stressed the importance of the precautionary principle written into the European treaties and accordingly pointed to the need for effective preventive measures to protect human health and avoid painful health issues or scandals of the kind already experienced over asbestos, tobacco smoking, lead and PCBs (polychlorobiphenyls), to name but a few. He presented a convincing analysis of the scientific assessment methods currently used and the different levels of evidence to conclude, on the basis of the "Bioinitiative" scientific report and other more recent studies by the Ramazzini Institute in Bologna, that the indices or levels of proof were sufficient at this stage to prompt action by governments and international bodies… a growing number of scientific studies made by teams of high-level academic researchers demonstrate the existence of potentially or definitely pathological biological effects…These studies are very numerous indeed: the 2007 "Bioinitiative" report analyzed over 2 000 of them."*

Notably, the European Environment Agency contributed a chapter to the Bioinitiative Report stating, "The report, 'Bioinitiative: A Rationale for a Biologically-Based Public Exposure Standard for Electromagnetic Fields' was compiled by the BioInitiative Working Group, an international group of scientists, researchers and public health policy

professionals. The EEA has contributed to this new report with a chapter drawn from the EEA study 'Late lessons from early warnings: the precautionary principle 1896–2000' published in 2001 (European Environment Agency, 2007).

Grimes' JAMA statement that the BIR has been “repeatedly debunked by health bodies worldwide” is not substantiated by the reference he provides. The entities he references are well outdated, industry tied and only one of these entities (Netherlands) could be considered even a “health body.”

- Further, the Bioinitiative has been updated since 2007 so none of these “debunks” are even based on the current report. The 2007 report was a 650-page report citing more than 2000 peer-reviewed studies from 1979 through 2006. In 2012 and 2014, the BioInitiative Report was updated with more than 1800 new studies on non-ionizing radiation and it is now a 1450-page report. Thus, Grimes put forward “debunks” that are not up to date and relevant.
- In summary- Grimes statements regarding the Bioinitiative are false mischaracterizations, outdated and do not even apply to the current Bioinitiative Report.

IX. Summary of Issues- Retraction needed.

1. If Grimes is going to reference the BioInitiative Report, it is inaccurate to refer to the report as “a non scholarly work” and he should clarify the subsequent publications of the materials in academic journals, the expertise of the 29 scientists, and the fact that it references thousands of peer reviewed articles.
2. Grimes should clarify the “debunking” was for the 2007 report, not the current report as the BIR was updated in 2012 with more than 1800 new studies on non-ionizing radiation and now twice as long. Thus, Grimes put forward “debunks” that are not up to date and relevant. If Grimes is going to state that the BioInitiative Report has been debunked, he should clarify that the“debunks” he refers to are over a decade old, based on the Bioinitiative 2007 but not for the current Biniontive Report.
3. If Grimes is going to state that the BioInitiative Report has been debunked, he should clarify that some of the entities he refers to as the “debunkers” are industry financed/tied.
4. Grimes cannot accurately state that the entities he refers to are “health bodies.”
5. Grimes should present the range of opinions on the Bioinitiative, rathan simply the few entities who “debunked” it- for example he should describe how the European Parliament and its member countries unanimously adopted Resolution

1815, which referenced the importance of the Bioinitiative Report in substantiating the Resolution.

X. Additional Comments

1. Grimes cherrypicks specific parts of various reports to present, omitting other highly relevant conclusions. In his Table "Summary of Recent Conclusions by Public Health Bodies Worldwide," Grimes references the Swedish Scientific Council on Electromagnetic Fields stating they conclude "no established causal relationship" get he omits that the same reports also conclude that "uncertainties regarding possible long-term effects justifies caution" and " The hands-free recommendation [meaning keeping the phone away from the brain via speakerphone or headset] for mobile phone calls remains…" (SSM's Scientific Council on & Electromagnetic Fields, 2018).

Issues RE Swedish Scientific Council on Electromagnetic Fields

- Grimes should put forward the full conclusions of the report including the recommendations to exercise "caution" and reduce exposure.

2.In the conflicts of interest section, it accurately states that," he also appeared in an informational video for Vodafone UK countering the fallacious connection between 5G and COVID-19 and donated these fees to Médecins Sans Frontières."

However the Vodaphone video was not just about COVID, it was also very clearly about health effects. The title of the webpage is "5G and health: Everything you need to know." In the video at 1:08 it states "Is 5G harmful to humans and nature?" and Grimes says "Some people have suggested that 5G technology can be harmful and even cause cancer. This is a misconception…" He states they don't have enough power to damage DNA…this means 5G won't harm bees or trees or human beings either." He then says at 2:05 "there have been thousands of scientific studies looking into this and the global consensus is that 5G poses no threat to health."

Further, Grimes states he donated the money from his Vodaphone video to Médecins Sans Frontières , did this impact his taxes in any way? Ifso this also should be referenced as it could have resulted in a tax break. Was proof provided of this donation?

Issues re Conflicts Section

1. The Conflicts section should state that he spoke about health effects specifically in his advertisement for Vodafone.
2. Details should be provided regarding proof of his donation.
3. If Grimes' tax level was impacted by his gift to Médecins Sans Frontières then this should be noted as well, especially if his tax braket changed due to the donation, or if he paid less taxes.

3. In "CONCLUSIONS AND RELEVANCE" in the abstract, Grimes states without substantiation that *"The evidence from these combined strands strongly indicates that claims of an RFR–cancer link are not supported by the current evidence base.*" However this conclusion is not based on any reference that Grimes has posted. No entity he references in this paper has reviewed all of the strands (evidence in humans and laboratory animals to date on the topic is also reviewed and discussed) with any systematic review, risk assessment or science based methodology in order to issue a determination regarding the RFR-cancer link- at least not since the 2011 WHO/IARC classification. As several publications have reviewed the human and animal research and determined that RFR is a carcinogen, he should reference these publications (Belpomme et al., 2018; Carlberg and Hardell, 2017; Directorate-General for Parliamentary Research Services (European Parliament) & Belpoggi, 2021; Lin, 2019; Miller et al., 2018; Melnick, 2019; Peleg et al., 2018; Portier 2021).

Issues re Abstract Section

1. This sentence must be removed. "The *evidence from these combined strands strongly indicates that claims of an RFR–cancer link are not supported by the current evidence base*." Grimes should clarify that no entity has systematically reviewed the human and animal evidence since 2011 when the IARC classified RFR as a possible human carcinogen. As several publications have reviewed the research and determined that RFR is a carcinogen, he should reference these publications.

4.Grimes omits all mention of how patients can reduce risk, via distancing the cell phone from the head. He should inform clinicians about these recommendations.

For example

- "Parents should consider reducing the time their children use cell phones and encourage them to turn the devices off at night" (California Department of Public Health, 2021)

- "It is "wise" to reduce RFR to one's brain" (Connecticut Department of Public Health, 2015).
- "Given the potential consequences for public health of this classification and findings it is important that additional research be conducted into the long-term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting," stated WHO/IARC Director Christopher Wild Press Release from WHO/IARC classification
- American Academy of Pediatrics Cell Phone Safety Tips For Families (American Academy of Pediatrics, 2016)
    - Use text messaging when possible, and use cell phones in speaker mode or with the use of hands-free kits.
    - When talking on the cell phone, try holding it an inch or more away from your head.
    - Make only short or essential calls on cell phones.
    - Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
    - Do not talk on the phone or text while driving. This increases the risk of automobile crashes.
    - Exercise caution when using a phone or texting while walking or performing other activities. "Distracted walking" injuries are also on the rise.
    - If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
    - Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. It's better to wait until you have a stronger signal before using your device.
    - Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
    - Remember that cell phones are not toys or teething items.

Issues

1. Grimes should include ways to reduce RFR exposure.

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5. Figure 1. Graphic on Electromagnetic Spectrum Has an Incorrect Range for Radio Frequencies.

In the first graphic Figure 1: The radiofrequency radiation (RFR) is incorrectly presented as spanning into infrared. However RFR is not the same as infrared. Although RFR is correctly stated as encompassing 3Hz to 3 THz the line showing RFR spans too wide. Further, RFR does not span all the way down to 0Hz as the graphic inaccurately depicts. This graph also needs to be corrected to include extremely low frequencies (ELF) such as power line line frequencies and even lower frequencies and direct current. JAMA Oncology should at least have the correct EMF spectrum presented.

Issues

1. The EMF Spectrum image needs to have the correct RFR range and include ELF and direct current.

A Final Note: By focusing only on the ionizing versus non-ionizing paradigm of harm, Grimes focuses only on DNA damage and omits that numerous effects have been found including structural and functional changes of the reproductive system, learning and memory deficits, and damage to the nervous system (Belpomme et al., 2018; Miller et., 2019; Schuermann et al., 2021). Just last year, two systematic reviews found impacts to sperm (Kim et al., 2021; Yu et al., 2021). A systematic review on the effects of RFR to male reproductive hormones found that wireless can decrease testosterone (Maluin et al, 2021). A systematic review published in the Annals of the New York Academy of Sciences found that neuronal ion channels are particularly affected (Bertagna et al., 2021). A 2021 review summarizes the effects of non ionizing EMFS on the neurotransmitters in the brain (Hu et al., 2021). A meta analysis of 300 peer-reviewed scientific publications (1990-2015) describing 1127 experimental observations in cell-based in vitro models on RFR published in Environmental Research found less differentiated cells such as epithelium and spermatozoa are more sensitive to RF (Halgamuge et al., 2020).

Although this review centers on cancer, a sentence about the additional effects researchers have found should have been presented for context.

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