



2024 Short Takes

NCI 'Cancer Bioelectricity' Conference

Michael Levin of Tufts University Will Be Keynote Speaker

August 26, 2024

On September 12th, the U.S. National Cancer Institute (NCI) will host a conference on cancer bioelectricity via Zoom.

[Michael Levin](#), a professor of biology and biomedical engineering at Tufts University in Massachusetts, will be the keynote speaker. The meeting begins at 8:30 am (U.S. Eastern Time) and ends at 4 pm. Attendance is free, but [registration](#) is required.

In an email announcement, NCI states:

"Bioelectricity regulates many life functions, and cancer cells have altered electrical properties which can disrupt the normal cellular signaling pathways leading to carcinogenic processes including tumor initiation, promotion and progression. Understanding cancer bioelectricity can lead to the development of novel approaches to cancer detection, diagnosis and therapy. The conference will address the fundamental aspects of cancer bioelectricity."

The program:

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NCI Conference on Cancer Bioelectricity
Thursday, September 12, 2024

8:30 Welcome

Keynote: Michael Levin, Tufts University

The Bioelectric basis of morphogenetic intelligence: a roadmap for cancer

9:30 Session 1: Bioelectricity in Normal Physiology

Michael Pycraft Hughes, Khalifa University

The cellular zeta potential: cell electrophysiology beyond the membrane

Emily Anne Bates, University of Colorado

Mechanisms underlying influence of bioelectricity in development

Robert Gatenby, Moffitt Cancer Center

Modeling non-genetic information dynamics in cells using reservoir computing

11:00 Session 2: Mechanisms of Bioelectricity

Joao Carvalho, University of Coimbra

A computational model of organism development and carcinogenesis resulting from cells' bioelectric properties

Xi Huang, University of Toronto

EGF receptor signaling is essential for electric-field-directed migration of breast cancer cells,

Min Zhao, University of California at Davis

The relationship between cancer bioelectricity and cancer genomics

12:30 Session 3: Bioelectricity and cancer

Mustafa Djamgoz, Imperial College London

Electrical signaling in cancer

Madeleine J Oudin, Tufts University

Potassium channel-driven bioelectric signaling regulates metastasis in triple-negative breast cancer,

Michael R. King, Vanderbilt University

Ion channels in cancer mechanotransduction

2:00 Session 4: Bioelectricity potential clinical and translational research

Donglu Shi, University of Cincinnati

Bioelectricity in nano-bioprobing and cancer diagnosis

Norbert Perrimon, Harvard Medical School

Bioelectric-dependent intestinal regeneration

Dany Spencer Adams, Tufts University

Cell membrane voltage imaging to identify cancer in biopsies and surgical specimens

Rosalia Moreddu, Istituto Italiano di Tecnologia

Nanotechnology and cancer bioelectricity: bridging the gap between biology and translational medicine

3:30 Panel Discussion: Moving cancer bioelectricity research forward

NCI SBIR funding opportunities for translational research

Concluding remarks

In her book, *We Are Electric*, published last year, Sally Adey describes Levin as “among those who have found evidence to suggest that the electrical dimensions of life can exert control over genes, providing a way to hack other systems we previously thought were too complex to precisely control.”

Some background reading on Levin's work:

- “The Biologist Blowing Our Minds,” *Nautilus*, June 28, 2023.
- “Brainless Embryos Suggest Bioelectricity Guides Growth,” *Quanta Magazine*, March 13, 2018.
- “This Scientist Re-Wires Frogs To Grow Extra Limbs. Could It Work in Humans?” *Popular Science*, December 26, 2016.
- “It's Electric: Biologists Seek to Crack Cell's Bioelectric Code,” *Scientific American*, March 23, 2013.
- “Voltage Change Forms Eyes in Head —or Wherever,” *Science*, December 9, 2011.

There's also Robert Becker's classic *The Body Electric*, still in print 40 years after it was first published.

Another WHO RF Review Challenged
More than 99% of Studies on Oxidative Stress
Discarded

A third RF systematic review commissioned by the World Health Organization's [EMF Project](#) is under fire. This one is on RF-induced [oxidative stress](#). Last month, two other WHO reviews —on pregnancy outcomes and on tinnitus— were both called into question as critics called for them to be [retracted](#).

A team of 14 from six countries, led by [Felix Meyer](#) of the German Office for Radiation Protection ([BfS](#)), identified 11,599 studies on oxidative stress in the frequency range 800-2450 MHz. They then eliminated 11,543 of them as not meeting their [criteria](#) for inclusion. Of the remaining 56, there are 45 animal studies and 11 cellular studies.

Meyer and colleagues [concluded](#):

“Overall, the effects were inconsistent across studies and there may be or may not be an effect of RF-EMF exposure, but the certainty of the evidence is very low.”

The review has been met with skepticism —at least by those not connected to the WHO, [ICNIRP](#) or the BfS.

“The authors of this ‘systematic review’ systematically excluded most of the relevant research,” [Joel Moskowitz](#) of the UC Berkeley School of Public Health said in an interview. “A strong case can be made that the Meyer review should be retracted.” Moskowitz runs the Electromagnetic Radiation Safety [website](#).

[Henry Lai](#), a professor emeritus at the University of Washington, Seattle, spelled out where Meyer and his team went wrong in the following statement he provided *Microwave News*:

The basic problem with this systematic review is that they ignored the dynamic nature of oxidative responses.

Proof of oxidative effects (possible oxidative stress) comes from different considerations:

1. Oxidative molecular reactions
2. Concentration of cellular free radicals
3. Changes in enzymes involved in free radical metabolism
4. Expression of genes involved in cellular oxidative processes, and
5. Inhibition by free radical scavengers (antioxidants).

These cellular responses, like most biological processes, have feedback loops — that is, they can compensate to maintain homeostasis. Overcompensation can lead to oscillations. Thus, it's possible to see an increase, decrease or no effect depending on when the measurement is made. It is not obvious how this dynamic might affect the outcome of Meyer's SR.

The Meyer review essentially only considered the first of the five possibilities above. These reactions include lipid peroxidation, protein oxidation and carboxylation, as well as DNA oxidation. Lipid and protein oxidation are relatively easy to measure. In RF studies, oxidative DNA

damage is usually studied using a type of comet assay or measurement of oxidized DNA bases. If the normal comet assay is used, the damage caused by free radicals would lead to single- and double-strand DNA breaks. There are many RF studies using the comet assay showing DNA strand breaks. I suspect most of these are caused by free radicals, because they can be blocked by antioxidants.

In addition, only two hydrogen peroxide studies were included. There are, however, many other types of cellular free radicals—for instance, reactive nitrogen species. It would have been more meaningful to look at the total oxidant status (TOS) and total antioxidant capacity (TAC). There are many studies reporting effects of RF radiation on TOS and TAC.

Finally, Meyer should have also considered studies of ELF-EMFs on cellular oxidative processes since most environmental RF is ELF-modulated. There are at least 320 published papers on oxidative effects of ELF/static-EMFs.

In sum, the Meyer review left out a large portion of RF-oxidative effect studies.

Lai compiles his own bibliography of RF-oxidative stress papers. As of mid-August, his list includes 367 studies, published between 1997 and 2024. By his count, 89% showed significant effects.

In a 2019 [review](#), Lai described some of the many biological impacts which may be caused by changes in the concentration of free radicals brought about by oxidative stress. These include “many physiological functions such as DNA damage; immune response; inflammatory response; cell proliferation and differentiation; wound healing; neural electrical activities; and behavior.”

The WHO systematic reviews are part of a more than a decade-long process to update its summary document on RF health effects. The project has been mired in delays and controversy. Details [here](#).

Fourth Review Questioned

August 23, 2024

Today, *Environment International* posted a [letter to the editor](#) in response to another WHO RF systematic review—this one on “[self-reported symptoms](#),” which was originally published in early April.

In his critique, Michael Bevington, the chair trustee of [Electrosensitivity UK](#), a charity based in London, states:

The review’s Interpretation is invalidated in three ways. Firstly, its parameters excluded much available evidence showing positive effects; secondly, the use of averaging hides individual cases which provide positive evidence; and, thirdly, its negative claim is contradicted by positive proof from other sources, including practical, judicial, legal and underwriting.

The lead author of the review is [Xavier Bosch-Capblanch](#), a medical doctor at the Swiss Tropical and Public Health Institute in Switzerland, who also has an appointment at the University of Basel. His team includes members from Nigeria, the U.K. and the U.S. —as well as Martin Rösli, a colleague of Bosch-Capblanch in Basel. Until recently, Rösli was a member of ICNIRP.

Bevington concludes:

“The claim that ‘available evidence’ suggests that acute non-thermal RF-EMF ‘does not cause symptoms’ is not substantiated by all the evidence available, including evidence from 1932 onwards when the condition of Radio Wave Sickness was first described...”

Note also: Bosch-Capblanch’s group has published a correction to the original paper to clean up “a few inconsistencies detected in the article after its publication, due to some dysfunctionalities in the proofreading process.” The published [Corrigendum](#) runs ten pages.

September 3, 2024

Environment International has posted Bosch-Capblanch’s three-point [response](#) to Bevington. The group argues that “Bevington seems to overlook the scientific approach of systematic reviews and meta-analyses.”

In a August 30 [Tweet](#) (X) noting the exchange, Rösli states: “The main purpose of a systematic review is to prevent confirmation bias.”

Jim Lin Offers Sharp Takedown of WHO Reviews

December 13, 2024

[James Lin](#), a former ICNIRP Commissioner, raises what he calls “significant concerns” over the reliability of four of the WHO systematic reviews in his long-running [column](#) in the *IEEE Microwave Magazine*.

World Health Organization’s EMF Project’s Systemic Reviews on the Association Between RF Exposure and Health Effects Encounter Challenges

■ [James C. Lin](#) 

Among his many criticisms, Lin cites the reviews’ “lack of concerns for conflicts of interest.”

Correction to Pregnancy & Birth Outcomes Review

January 21, 2025

The authors of the WHO systematic review on RF [effects on pregnancy and birth outcomes](#) in animals have issued a [correction](#).

They report finding “a few inconsistencies” due to “errors” in the “extraction of the original data.” But, they “stress” that “none of these issues has produced any significant change in the quantitative outputs of the effects estimates or in the interpretation and conclusions of the systematic review.”

Italy's 6 V/m RF Limit at Risk

Industry Sees Strict Standard as Barrier to 5G Development Seeks To Bring It into Line with ICNIRP

March 14, 2024

This is a continuing story —with the most recent updates on top.

The International Commission on the Biological Effects of Electromagnetic Fields ([ICBE-EMF](#)) has written to Italian government officials to support the country's strict 6 V/m RF exposure limit.

The letter, dated March 13, expresses “great concern” that the standard might be weakened. It is signed by [Ronald Melnick](#), the chair of ICBE-EMF, and by [Elizabeth Kelley](#), its managing director. Before his retirement, Melnick was a senior toxicologist at the U.S. [NTP](#). He designed the NTP RF–cancer [animal study](#).

The letter begins:



13 Marzo 2024

Letter of support for the 6x6 Network Appeal opposing the new Italian law that increases radiofrequency radiation (RFR) exposure limits.

We are contacting you on behalf of the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF.org), an international organization composed of scientists, engineers, physicians and others, who are dedicated to ensuring the protection of humans and other species from the harmful effects of non-ionizing radiation. Our primary purpose is to make recommendations, based on the best scientific peer-reviewed publications, that include and go beyond setting guidelines on numerical exposure. We are totally independent of industry while promoting technological solutions that protect human health.

We fully support the Appeal that you have received from the 6x6 Network opposing the new law, issued on December 30, 2023, by the Italian Parliament, pursuant to Article 10 of Law No. 214, which raises radiofrequency human exposure limits.

We agree with the scientists, physicists, engineers, and doctors who signed the 6x6 Network Appeal, that this new law violates the rights of individuals, their health and environmental quality. As the industry pushes the expansion of wireless exposures into its 5th generation, only a few studies on the biological and health effects of the frequencies and pulsations used by these new systems have been performed. The experience we have from previous generations (1G-4G) indicates that the current exposure limits that were established approximately 25 years ago were based on a behavioral effect in experimental animals that was observed after short-term exposures (up to one hour). Long-term effects of electromagnetic radiation that are of public health concern have been ignored by ICNIRP in their guidelines for limiting RFR exposures.

A full copy of the four-page letter is available in [English](#) and in [Italian](#). See also the scientists' [appeal](#) to keep the Italian limit, issued last August.

The ICBE-EMF was set up in March 2021, as a counterweight to ICNIRP, more [here](#).

December 31, 2023

As the year comes to a close, the 6 V/m appears, once again, very vulnerable. Stay tuned as the situation plays out over the coming months.

August 9, 2023

The Italian government has **signaled** that it intends to keep its strict 6 V/m RF radiation exposure limit.



Below is our original story, posted more than two years ago, when the limit was first under pressure.

May 3, 2021

Italy's 6 V/m RF exposure standard, one of the strictest in the world, may soon fall victim to 5G.

The Italian limit, adopted more than 20 years ago, is widely perceived as standing in the way of the build-out of 5G infrastructure, which will require the installation of many more RF antennas. The proposed solution is to make the standard ten times weaker and bring it in line with ICNIRP's 61 V/m guideline.*

The standard is a target of Italy's post-pandemic national recovery plan (known as the **Next Generation Italia** or **PNRR**). The plan allocates over €40 billion (~US\$48 billion) to advance the digitization of the country, including promoting 5G technology and

increasing broadband speeds nationwide, currently among the [slowest](#) in Europe.

All the major political parties, except one, favor loosening the 6 V/m limit, according to [La Repubblica](#), the second most widely read (non-sport) newspaper in Italy. The one holdout is the [Fratelli d'Italia](#) party (Brothers of Italy), a far-right, neo-fascist group—and even it is on record as wanting to make the siting of antennas easier for telecom operators.

The proposal has galvanized a coalition of Italian environmental researchers and activists, as well as members of the international RF research community. They have appealed to the government to save the 6 V/m limit. (See Tweets below.)

One [appeal](#), sent to [Mario Draghi](#), the recently installed prime minister, on April 26, had been signed by more than 8,700 supporters within a couple of days, according to [Fiorella Belpoggi](#). She is the scientific director of the [Ramazzini Institute](#) in Bologna and is helping coordinate the campaign.

Italy has long been a hotbed of anti-5G activism. A [petition](#) calling for a moratorium on 5G, launched two years ago, has garnered more than 63,000 signatures. The [Italian Stop 5G Alliance](#) has been a major force in promoting this petition.

The protests—including a [hunger strike](#) by over 150 people—appears to have softened the government's approach. When the lower house of the Parliament approved the recovery plan at the end of April, the proposal to eliminate the 6 V/m limit had been dropped and replaced by a call to review the standard.[‡] But, Belpoggi told *Microwave News*, “the door for a change remains open.”

All Eyes on Vittorio Colao

Much of the public furor at the potential weakening of the exposure limit has been directed at [Vittorio Colao](#), the Harvard-educated minister for innovation, technology and digitization in the new Draghi government.

Colao was the chief executive of [Vodafone](#), the largest telecommunications company in Europe, for ten years, ending in late 2018. The following year he became a director of [Verizon](#), the second biggest telecom in the world (after AT&T) and, like Colao himself, a major promoter of 5G technology. Colao has now stepped down from the Verizon board. He has been praised as a “[strategic visionary](#).”

Colao played a major role in designing the PNRR. He was commissioned by the previous Italian prime minister, Giuseppe Conte, to devise a post-COVID recovery strategy, which became known as the [Colao plan](#). It included investments in infrastructure.

That [plan](#), delivered to Conte last June, proposed raising Italy's exposure limits to those recommended by the EC[†] (that is, the ICNIRP limits), according to [Livio Giuliani](#), the former director of

research at Italy's National Institute for Prevention and Occupational Safety ([ISPESL](#), now [INAIL](#)). The 2020 plan[‡] also favored giving national authorities the right to veto local ordinances that block antennas.[§] (This would be similar to the federal preemption of local laws in the U.S.)

The new digitization initiative, which Colao would most likely implement, accounts for about 20% of the total outlays under the €200 billion PNRR.

In a meeting with legislators in April, Colao acknowledged that a weakening of the 6 V/m limit is “unpopular.” He committed to striking a balance between the number of antennas and the health and welfare of the citizenry, pledging that, “the scientific evidence would be evaluated,” according to *La Repubblica*.

When the 6 V/m standard took effect in 1999, Italy had the most restrictive standard in Europe. A year later, Switzerland adopted a 4 V/m limit for cell tower radiation and a 3 V/m limit for radio and TV transmitters (details [here](#)).

The 6 V/m limit is approximately the same as the Soviet/Russian exposure standard of 10 $\mu\text{W}/\text{cm}^2$.

It is not clear what impact the Italian standard may have had on the build-out of the mobile phone network or would have on 5G antennas.

The April 26 appeal to Draghi concludes:

“Italy has led the world for the last 20 years in demonstrating that their lower and more health protective exposure limits for RFR can be reached by the Italian Telecommunications industry without significant economic or technical barriers to their expansion into 4 and 5G systems.”

Here's a [thread](#) of *Microwave News* Tweets, posted last week as some of this story played out:



Microwave News
@MicrowaveNews

...

Concern is building in Italy over possible loosening of its [#RF](#) exposure standard—one of the strictest in the world—by as much as 100x. In a letter to 🇮🇹 PM Mario Draghi, 29 associations asked that the government maintain its 6 V/m limit.

Press release 📧

applelettrosmog.it/file/news/APPL...



[Link](#) to press release



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...

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A similar letter has also been sent to Draghi by ~40 🇮🇹 researchers, academics, politicians & activists.

[@CollegiumRamazz](#), [@Legambiente](#) + numerous anti-[#5G](#) groups are represented.

Letter 📧

vogliamolimiticautelativi.it/lettera-al-pre...

Posted under the banner:

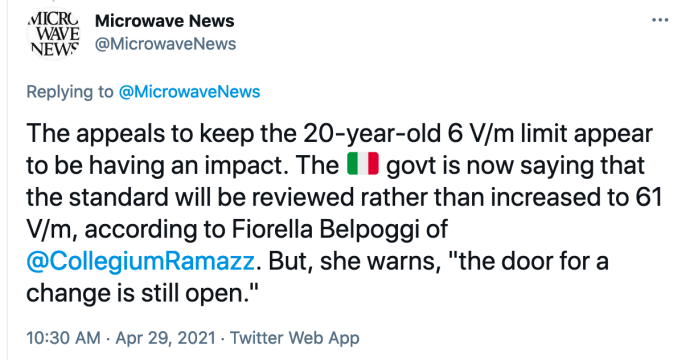
"We Want 6 V/m — Not One More"



[Link](#) to letter



[Link to letter](#)



* How much weaker is the ICNIRP standard than Italy's 6 V/m limit? It depends on whether you are looking at the electric field or power density. The 6 V/m electric field standard is approximately ten times stricter than ICNIRP's 61 V/m. In terms of power density, the Italian limit is about a hundred times stricter than ICNIRP ($10 \mu\text{W}/\text{cm}^2$ v. $1 \text{ mW}/\text{cm}^2$). The reason: Power density is proportional to the square of the electric field strength.

† In 1999, the EC [recommended](#) that member states follow the ICNIRP guidelines. From the Italian Parliament on March 24, 2021: "Consider adjusting the current Italian limits on electromagnetic emissions to the European ones." ([Item #15 on p.76.](#))

‡ See also the July 2020 [report](#) on 5G from a committee of the Italian Parliament.

§ See item #27 on p.22 of the June 2020 [Colao plan](#). Some 500 municipalities have policies that make it hard to site antennas, [La Repubblica](#) reported last year.

"NTP Lite": Update from Japan

Prof. Katsumi Imaida To Present at Tox Meeting in Utah

March 12, 2024

The Japanese group running a partial repeat of the NTP RF cancer study has not observed genotoxic effects among male rats exposed

to 900 MHz CDMA radiation at 4 W/Kg, according to a paper to be presented tomorrow at the annual meeting of the Society of Toxicology in Salt Lake City, UT ([SOT2024](#)).

The genotox studies were carried out following 14 weeks of RF exposure.

The analysis of the cancer data is ongoing and will not be reported.

Among the long-term results reported by the Japanese team:

- Body weights and food consumption of the exposed rats were significantly different from the controls.
- After two years, more of both the exposed and control rats in Japan had survived than in the NTP experiment. This was “especially” noteworthy for the controls.

Professor [Katsumi Imaida](#) of Kagawa University in Takamatsu, the lead author of the paper, is scheduled to present these results at the SOT meeting. They are essentially the same as those he [presented](#) at the [BioEM2023](#) meeting last June in Oxford, England.

A parallel project is also ongoing in Korea and the data from each will be pooled to improve the statistical reliability of the results. The [Japanese/Korean animal study](#) is a scaled-down repeat of the \$30 million study by the U.S. National Toxicology Program (NTP), which found [clear evidence](#) that RF radiation can cause cancer. The Asian study has been dubbed “NTP Lite”. The project is being called a “validation” study.

In contrast to the Japanese findings, the NTP team did [see DNA breaks](#) (NTP paper [here](#)). Both U.S. and the Japanese groups used the comet assay, developed by [N.P. Singh](#).

Last June, [Young Hwan Ahn](#), the leader of the Korean project team, presented his own [status report](#) at a private briefing for the WHO EMF Project in Geneva. At the time, he revealed that the Korean genotox experiments had to be delayed due to the unexpected death of four RF-exposed rats early in the two-year experiment.

For more on the joint Japanese/Korean project, see Ahn and Imaida's [2022 paper](#) in *Bioelectromagnetics* (open access).

Members of the project's [international advisory committee](#) are: Alexander Lerchl, Michael Repacholi, Emilie van Deventer, Eric van Rongen, Vijayalaxmi, Joe Wiart and Michael Wyde.

**Prof. K. Imaida's Poster Paper at SOT 2024 in Utah,
March 13, 2024**

A Long-Term Carcinogenicity Bioassay and *in vivo* Genotoxicity Studies by Electromagnetic Fields Exposures Using Male Rats: Validation Studies of NTP Bioassay in Japan

K. Imaida¹, M. Kawabe², J. Wang³, and M. Yokohira¹

¹Kagawa University, Takamatsu, Kagawa, Japan; ²BioSafety Research Center Inc., Iwata City, Shizuoka, Japan; and ³Nagoya Institute of Technology, Nagoya, Aichi, Japan.

Background and Purpose: The US National Toxicology Program (NTP) reported that code division multiple access (CDMA) and global system for mobile communications (GSM) modulated mobile phone radiofrequency electromagnetic fields (EMF, 900MHz) to be carcinogenic to the brain (glioma) and heart (malignant schwannoma) of male rats. In order to verify the NTP study results, Japan and Korea started our collaborative animal carcinogenicity projects using the same animal experiment protocol, the same animal model, and the same EMF exposure conditions.

Methods: The protocols of animal studies are similar to those of the NTP studies. Harlan SD, male rats were used. The EMF, 900MHz CDMA modulated signal, 4W/Kg SAR, were performed in the reverberation chambers, set up inside animal rooms. The reverberation chambers are equipped with two stirrers, vertically and horizontally, and two antennas inside a metal box. There are three animal groups, i.e., the exposed group, the sham exposed group (set up inside the chamber) and the cage control group (outside the chamber). Each group had 70 male rats for the carcinogenicity study and 5 rats for the genotoxicity study. In the exposed group, the exposure was started at the gestation day 5 of pregnant rats, and after their delivery, the pups were exposed by the EMF continued through for 104 weeks after their weaning, same as that of NTP. In the genotoxicity studies, after 14 weeks exposure after the weaning, comet assay of all of liver, peripheral blood, cerebellum, hippocampus and frontal cortex of rats were performed.

Results: In the genotoxicity studies, comet assay of all organs examined, including showed negative, and the micronucleus tests also showed negative results. In the carcinogenicity study, 104 weeks EMF exposures after their weaning to the rats have been finished and all of animals were sacrificed for the histopathological evaluation. The histopathological evaluation is now undergoing. Body weights of the exposed group were significantly less than the sham exposed group except for the last about 20 weeks. Food consumptions of the exposed group were also significantly less than the sham exposed and the cage control groups. Survival rates at the 104 weeks were 64.7% in the RF exposed.

[Click to enlarge.](#)