New Hampshire Commission to Study the Health Effects of Evolving 5G Technology Nov 21, 2019

THE HEALTH EFFECTS OF RADIOFREQUENCY RADIATION

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a word about me...

Eric Swanson



- professor of physics at the University of Pittsburgh
- 100+ publications in biophysics, nuclear, and condensed matter physics
- Fellow of the American Physical Society



• founder APS Topical Group on Hadronic Physics

Author of two textbooks



JOSEPH F. BOUDREAU | ERIC S. SWANSON with contributions from Riccardo Maria Bianchi



and many op-eds





robotic cars

missile defence



cellphones do not cause cancer



bad science

Why the Higgs Particle Matters



climate change



quantum reality

1. A Bit of Electromagnetic History

Interest in the effects of electricity and magnetism on the body dates from the very beginnings of the science...



Luigi Galvani, 1737-1798





Alessandro Volta, 1745-1827



Galvani thought he had discovered something about life. Volta showed that electricity actually concerned metals and fluids.

But the idea that electricity has something to do with life continues. Perhaps the most famous example is Mary Shelley's **Frankenstein.**



Frankenstein (1931) © Universal Studios



Mary Shelley 1797 - 1851

Franz Mesmer (of "mesmerize") promoted the idea that **magnetism** had something to do with life.



Franz Mesmer, 1734-1815



Concern about new technology and electromagnetism is not new.



As are claims that it has detrimental health effects.

Statements have been made in the medical and general Press that the electric waves used in wireless telegraphy are injurious to the operators and produce various diseases, such as conjunctivitis, corneal ulceration, and leukoma. Mr. Marconi writes to the Times to deny these suggestions, for which, he says, there is no evidence whatever. He adds: – "During the twelve years or so of our operations we have had to deal with no single case of compensation for any injury of this origin, nor, so far as I can ascertain, has any such injury been suffered. Speaking for myself, I may remark that my own good health has never been better than during the often extended periods when I have been exposed for many hours daily to the conditions now challenged, and in the constant neighbourhood of electrical discharges at our Transatlantic stations, which I believe are the most powerful in the world."

Interest in electricity and magnetism and the body dates from the very beginnings of the science... **and continues to this day.**

Thousands of studies concerning electromagnetism and the body have been made.

A partial table of contents from one compendium:

- cellular and molecular biology
 - chromosome-genetic effects
 - hyperthermia and cell kinetics
 - carcinogenesis
 - transcription
 - melanoma
 - lymphoma
 - breast cancer
 - brain cancer
 - leukemia
 - leukosis
 - prostate cancer
 - pineal function
- biochemical changes
- reproduction
 - the gonads
 - embryonic development
 - developmental behaviour
- effects on the nervous system
 - electroencaphalographic changes
 - neuroregenerative effects
 - ganglion explants
 - cultured neuroblasts
 - peripheral nerves
 - spinal cord

- calcium efflux
- histopathology
- effects on the blood-brain barrier
- influence on drugs
- behavioral thermoregulation
- neuroendocrine effects
 - mechanisms of interaction
 - hypothalamic-hypophysial-adrenal response
 - hypothalamic-hypophysial-thyroid response
- cardiovascular effects
- effects on hematopoiesis and hematology
- effects on immune response
 - lymphoblastoid transformation
 - lymphocyte mitotic stimulation
 - adaptation
 - lymphocyte proliferation
 - lectin concentration
 - RNA metabolism
 - influence of hyperthermia
 - growth factors
 - Ca transport
- auditory response

- occular effects
 - threshold for opacity
 - biochemical changes
 - thermal aspects of microwave cataractogensis
- galvanotaxis
 - cell shape
 - role of calcium
 - cell motilitty
- galvanotropism
- orthopaedics
 - fracture nonunion
 - failed fusion
 - congential pseudoarthrosis
 - osteonecrosis
 - osteoporosis
 - chronic refractory tendinitis
 - osteochondritis dissecans
 - osteogenesis imperfecta

Unfortunately there is a lot of misinformation and misunderstanding out there. + Fear of the unknown =

trouble!

Consider, for example, what worried us 30 years ago (and has long since been debunked).



Or what worried us 15 years ago.

Vatican radio waves blamed for high cancer risk

cancer.



Video and Audio

Two scientific studies have suggested a field of Vatican Radio broadcasting antennas north of Rome may have caused high rates of cancer in the area.

Or what worried us 3 years ago.



Could Cell Phones Be Killing the Honey Bee?

Fear of the unknown is what links these past worries with the current ones about 5G and cellphones.

Ironically, we also love electromagnetic radiation!

Rachel Ray hawks the "Zerona", which purports to cause fat loss with red pencil lasers.



Although they have no known health effects, \$300 million of magnetic bracelets are sold annually in the USA.

Magnetic Bracelet on Sale

Magnetic therapy bracelets on sale. Free shipping. WellnessMarketer.com is rated ***** (110 reviews) www.WellnessMarketer.com

Sabona Magnetic Bracelets

Save 10% Plus \$10 Rebate on Sabona Bracelets over \$39.95 Free Shipping Sabona Athletic - Sabona Ladies - Sabona Men's - Sabona Copper www.OverstockBracelets.com





Sabona Mens Steel Sport Magnetic Bracelet - S/m \$19.99 Target Trion:Z Dual Loop Magnetic/Ion Bracelets \$19.99 Golf Galaxy Sabona Lady Executive Silver Gem Magnetic Bracelet \$45.99 Overstock.com Sabona Trio Cable Black/Satin Stainless Magnetic Bracelet (SIZE: ... \$74.99 Amazon.com Ads

Millimeter wave (MMW) electromagnetic radiation is used as **therapy** in Russia.

MMW therapy is a widely used therapeutic technique that has been officially approved by the Russian Ministry of Health. In fact, it has been reported that, as of 1995, more than 3 million people have received this therapy at over 1,000 MMW therapy centers in Russia. MMW therapy has been reported to be efficacious in the treatment of over 50 diseases and conditions (Pakhomov

K.L. Ryan et al., Health Physics, 78, 170 (2000).

Millimeter wave (MMW) electromagnetic radiation is used as **therapy** in Russia.

MMW therapy is a widely used therapeutic technique that has been officially approved by the Russian Ministry of Health. In fact, it has been reported that, as of 1995, more than 3 million people have received this therapy at over 1,000 MMW therapy centers in Russia. MMW therapy has been reported to be efficacious in the treatment of over 50 diseases and conditions (Pakhomov

K.L. Ryan et al., Health Physics, 78, 170 (2000).

It is not plausible that the same radiation <u>causes</u> 50 diseases and <u>cures</u> 50 diseases. The explanation is that it does neither, as I will explain in a few minutes.

2. Electromagnetic Basics





James Clerk Maxwell (1831 – 1879) Scottish physicist.

Electromagnetic radiation is the best understood phenomenon in the universe.

It is **not** nuclear radiation!

It is completely described by three numbers (intensity, frequency, and polarization)

The electromagnetic spectrum





3. Health Effects of Electromagnetic Radiation





High frequency radiation is damaging and is called **ionizing**

Mild DNA damage by UV light triggers the production of melanin



The left side of this truck driver's face has been exposed to the sun over long periods.



Why short wavelength light has higher energy than long wavelength.



the photoelectric effect





Photoelectric effect

the photoelectric effect



The photoelectric effect tells us that

Othere is no "cumulative effect" due to nonionizing radiation

The intensity of nonionizing radiation has no effect on cancer


ionizing

non-ionizing



Nonionizing radiation has no known effect on the human body other than heating.





4. FCC Regulations

The FCC does not conduct experiments — it sets regulatory limits based on the evaluation of relevant literature made by many national and international agencies.

1000's of studies have been examined

FDA, EPA, OSHA, National Institute for Occupational Safety and Health, National Council on Radiation Protection, IEEE, etc

One of these agencies is the IEEE

The IEEE has a rigorous policy creation process!



Figure 4—Flowchart of IEEE process for development of C95.1 standards

"At the literature evaluation cutoff date, 31 December 2003, the Literature Surveillance Working Group identified over 2200 papers from a number of databases and inputs from federal agencies and other organizations that were regularly polled. "

The IEEE has a rigorous policy creation process!

Affiliation	Number	Percentage
Research University:	37	29.6
Nonprofit	8	6.4
Military	15	12.0
Government (FDA, EPA, etc.)	30	24.0
Industry	12	9.6
Industry – Consulting	4	3.2
Government – Administration	5	4.0
General Public and Independent Consultants	14	11.2
Total	125	100

Table 1a. The affiliations of the 125 members of Subcommittee 4 of IEEE Standards Coordinating Committee 28 at the time the 1991 IEEE C95.1 standard was approved.

Principle Discipline	Number	Percentage
Physical Sciences (Physics, Biophysics, etc.)	41	32.8
Life Sciences (Biology, Genetics, etc.)	54	43.2
Medicine (Physicians)	12	9.6
Radiology, Pharmacology, Toxicology	4	3.2
Others (Law, Medical History, Safety, etc.)	14	11.2
Total	125	100

Table 1b. The principle disciplines of the 125 members of Subcommittee 4 of IEEE Standards Coordinating Committee 28 at the time the 1991 C95.1 standard was approved.

5G is new. The physics and biology of 5G is not.

Animal studies indicate that effects due to heating start at ~10W/kg.

Appetite change, behavioral changes, etc

The FCC limit for the general public is

SAR < 1.6W/kg.

"Specific absorption rate" chiefly used for lower frequencies whole body FCC limit is **50** times lower than detectable

For comparison, my heating pad produces about 100W/kg



The FCC also limits the energy deposition per unit area:

$MPE < 1 \text{ mW/cm}^2$ (10 W/m²)

"maximum permissible exposure" chiefly used for higher frequencies effects in humans (lens opacity) start at ~ 100 mW/cm²

Hirsch, F. T. and Parker, J. T., "Bilateral lenticular opacities occurring in a technician operating a microwave generator," *A. M. A Arch. Ind. Health*, vol. 6, pp. 512-517, December, 1952.

Two standards are used because it is difficult to measure SAR at high frequencies since the radiation is absorbed by a thin layer of skin.

> MPE for frequencies greater than 6 GHz SAR for frequencies less

Exposure due to a 4G tower

As a fraction of MPE Computed using the 1/r² law



Exposure due to a 5G small cell

/

As a fraction of MPE Computed using the 1/r² law



Exposure due to a 100W light bulb

As a fraction of MPE

Computed using the $1/r^2$ law



Exposure due to the sun

As a fraction of MPE Computed using the 1/r² law



The brain is a 15W electromagnetic thermal radiation transmitter SAR ~ 15 W/kg

Stepping outside without a hat on: SAR ~ 20W/kg





Temperature increase in skin due to various MPEs



Fig. 7. Steady state temperature elevation at 60 GHz with different incident power densities in naked skin (model 1) [3].

T. Wu, T. S. Rappaport, C. M. Collins, "The Human Body and Millimeter-Wave Wireless Communication Systems: Interactions and Implications," accepted in 2015 IEEE International Conference on Communications (ICC), Jun. 2015.

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5. Studies

In the internet age it is possible to find a "respectable" source that says **anything**, from silly, to ludicrous, to dangerous:









It is therefore important to search out expert consensus views.

Statements from National Bodies

The Federal Communications Commission (FCC):

"As discussed above, radiofrequency emissions from antennas used for cellular and PCS transmissions result in exposure levels on the ground that are typically thousands of times below safety limits. These safety limits were adopted by the FCC based on the recommendations of expert organizations and endorsed by agencies of the Federal Government responsible for health and safety. Therefore, there is no reason to believe that such towers could constitute a potential health hazard to nearby residents or students."

The Food and Drug Administration (FDA):

"Based on our ongoing evaluation of this issue, the totality of the available scientific evidence continues to not support adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits."

National Cancer Institute:

"... although many studies have examined the potential health effects of non-ionizing radiation from radar, microwave ovens, cell phones, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans."

American Cancer Society:

"At ground level near typical cellular base stations, the amount of RF energy is thousands of times less than the limits for safe exposure set by the US Federal Communication Commission (FCC) and other regulatory authorities ... Some people have expressed concern that living, working, or going to school near a cell phone tower might increase the risk of cancer or other health problems. At this time, there is very little evidence to support this idea."

Statements from International Bodies

European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2015):

"Overall, the epidemiological studies on mobile phone RF EMF exposure do not show an increased risk of brain tumours. Furthermore, they do not indicate an increased risk for other cancers of the head and neck region."

World Health Organization (2006):

"Recent surveys have indicated that RF exposures from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards . . . From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF signals produced by base stations."

Health Canada (2014):

"The Panel has concluded that the balance of evidence at this time does not indicate negative health effects from exposure to RF energy below the limits recommended in the Safety Code."

United Kingdom Health Protection Agency Independent Advisory Group on Non-Ionizing Radiation (HPA) (2012):

"In summary, although a substantial amount of research has been conducted in this area, there is no convincing evidence that RF field exposure below guideline levels causes health effects in adults or children."

Swedish Council for Working Life and Social Research (2012):

"Extensive research for more than a decade has not detected anything new regarding interaction mechanisms between radiofrequency fields and the human body and has found no evidence for health risks below current exposure guidelines."

Norwegian Institute for Public Health (2012):

"The studies have been performed on cells and tissues, and in animals and humans. The effects that have been studied apply to changes in organ systems, functions and other effects. There are also a large number of population studies with an emphasis on studies of cancer risk. The large total number of studies provides no evidence that exposure to weak RF fields causes adverse health effects."

Statements from International Bodies

Australian Radiation Protection and Nuclear Safety Agency (Nov, 2019):

"Current research indicates that there is no established evidence for health effects from radio waves used in mobile telecommunications. This includes the upcoming roll-out of the 5G network."

The upshot:

Trends in age-standardized incidence rates of glioma in the United States, 1985-2015 (SEER Registry) vs. cell phone subscriptions



Calendar Year

We know how difficult it is to perform reliable studies...

... from conflicting claims in the press ...

... and from repeated studies...

widespread. A few years ago scientists at Amgen, an American drug company, tried to replicate 53 studies that they considered landmarks in the basic science of cancer, often co-operating closely with the original researchers to ensure that their experimental technique matched the one used first time round. According to a piece they wrote last year in *Nature*, a leading scientific journal, they were able to reproduce the original results in just six. Months earlier Florian Prinz and his colleagues at Bayer HealthCare, a German pharmaceutical giant, reported in *Nature Reviews Drug Discovery*, a sister journal, that they had successfully reproduced the published results in just a quarter of 67 seminal studies.

... and from studies of studies...

the Atlantic

November 2010

CURRENT EVENTS

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FOREICH POLICY TRAVE CULTU \$140B p.a. medical research FOLLS field is dysfunctional!

Lies, Damned Lies, and Med Science

MUCH OF WHAT MEDICAL RESEARCHERS CONCLUDE IN THEIR STUDIES IS MISLEADING, EXAGGERATED, OR FLAT-

OUT WRONG. SO WHY ARE DOCTORS-TO A STRIKING EXTENT-STILL DRAWING UPON MISINFORMATION IN

THEIR EVERYDAY PRACTICE? DR. JOHN IOANNIDIS HAS SPENT HIS CAREER CHALLENGING HIS PEERS BY

EXPOSING THEIR BAD SCIENCE.

convincingly refuted: 80 percent of non-randomized studies (by far the most common type) turn out to be wrong, as do 25 percent of supposedly gold-standard randomized trials, and as much as 10 percent of the platinum-standard large randomized trials. The article spelled out his belief that Amongst the many reasons for this are:

study biases (recall, reporting, etc)
lack of blinding
difficulty working with human or animal subjects
the rarity of the effects being sought
the expense of dealing with many test subjects

The problem of multiple comparisons.

Conduct a thorough experiment

outcome 100

67



assume a P-value of 1%

P-value: the probability of observing the effect seen, or greater, given that the null hypothesis is true





The problem of multiple comparisons

expt A expt B expt C



exposure \rightarrow









exposure \rightarrow

Random? Yes.


How are these random results reported?

EM Watch	EMF Safety and Health Power lines EMF	<u>Contact us</u>
Home V	What is EMF? EMF Health Effects Who is at risk? EMF Protection	EMF Survey
Now find out about: <u>Cell Phone Radiation</u> <u>Cell Tower Health Risks</u>	Living Close to Power Lines Power Lines Health Risks	Select Language + Powered by Google [™] Translate
<u>Computer Radiation.</u> <u>Appliance/TV Radiation</u> <u>House Wiring EMF</u> <u>Microwave Radiation</u>	GROUPON See Today's Deal www.Groupon.com There has been controversy over power line radiation and its effect on human health for at least 40 years. This is not because evidence is lacking.	You CAN Succeed at whatever you choose. Knowledge gives Power to Change your Destiny! digitalistix.com
Living near Power Lines Other sources of EMF EMF Table EMF Survey	Living by power lines has been known to increase the risk of leukemia and other cancers since 1979, when convincing evidence was first published by Werthimer and Leeper.	Share this Page:
EMF Meters/Detectors More EMF Websites Useful EMF Articles Privacy Policy Health eBook Store	Since then, dozens of published papers have found links between living near power line electromagnetic radiation and a range of health woes including brain cancer and leukemia (especially affecting children), breast cancer, birth defects and reproductive problems, decreased libido, fatigue, depression, blood diseases, hormonal imbalances, heart disease, sleeping disorders and many others.	Ads by Google Radiation Reatments Chat w/a Cancer Info Expert About Radiation Treatment Options. www.CancerCenter.com



A single exposure causing many outcomes is a sure sign of the multiple comparisons problem!

The NTP Study

The claim:

• "there is *clear evidence* that RFR causes heart tumors in male rats"

this is an NTP technical term

• "there is *some evidence* that RFR causes brain tumors in male rats" also an NTP technical term

- Glioma is rare (the incidence rate in the USA is approximately 3 per 100,000 persons, and it is expensive and difficult to perform experiments on a sufficient number of rats to obtain statistically reliable results.
- A study examining cancer rates in Sprague-Dawley rats (the type used in the NTP study) found that tumor incidence varied greatly depending on the commercial source. The authors "stressed the need for extreme caution in evaluation of carcinogenicity studies conducted at different laboratories and/or on rats from different sources."
- Sprague-Dawley rats are known to produce tumors at a high and very variable rate .
- Neither the dose nor the exposure time were consistent with typical and FCC-permitted human use.
- The study found difficulty in consistently evaluating whether the test animals actually had diseases of a given type.
- The NTP study reports that rats that were exposed to RFR actually *lived longer* than the control group (which was not exposed to RFR).
- Only three female rats were observed with gliomas compared to 11 male rats. It is very difficult to find a plausible biological explanation for a sexual difference in the incidence of brain cancer.

- The NTP study exposed four different groups of animals to two types of signal modulation (CDMA and GSM) at three different levels of exposure. Furthermore, the animals were examined for many types of cancer. Statistically, the resulting multitude of subclasses **must** lead to false positives.
- External referee, Dr. Michael S Lauer: "The low power implies that there is a high risk of false positive findings, especially since the epidemiological literature questions the purported association between cell phone exposure and cancer."
- The NTP cautioned that their "findings should not be directly extrapolated to human cell phone usage."
- When analyzing **all** NTP experiments a **lower** rate of glioma was found for rats exposed to RFR.

Chamberlin Presentation

The claim: power per unit area becomes alarmingly large

Significance of 1/R² Power Relationship



As reference, assume power density at 1 meter is equal to unity. $P = 1 W/m^2$



In this case, distance is equal to fabric thickness (0.2 mm), so $P = 24 \text{ MW/m}^2$



If phone is moved to a distance of 0.5 m, P = 4 W/m²



Definitely not a good idea!

This is misleading!





```
antenna size D ~ 5m
wavelength \lambda = 1 cm (30 GHz)
Frauenhofer distance 2 D<sup>2</sup>/\lambda = 50 cm
```



```
antenna size D ~ 5m
wavelength \lambda = 1 cm (30 GHz)
Frauenhofer distance 2 D<sup>2</sup>/\lambda = 50 cm
```











The actual situation is more complicated —- numerical work is required as it is even difficult to measure the energy density.



Peak 1g SAR: 0.50 mW/g

C. Rowell and E.Y. Lam, IEEE (2012)

Heroux Theory

The claim: electric fields from cellphones disrupt proton transfer in water, thereby "influencing the properties of water and the stability of DNA". The acid-base reaction creates H₃O molecules

 $2H_2O \leftrightarrow OH^- + H_3O^+$

There is about 1 H₃O molecule per 10 million H₂O molecules

The 'extra' proton can hop along chains of water molecules — this is called the Grotthuss mechanism.



All of these things are normal chemical reactions and it valid to ask:

What is the effect of an electric field on chemical reactions?

This is studied by, eg, the Boxer lab at Stanford, who use electric fields of strength 2000000 V/cm to 100000000 V/cm.



https://www.boxerlab.stanford.edu/electrostatics-in-enzyme-catalysis

cellphones max out at 1V/cm!

Nasim and Kim

The claim: 5G far exceeds FCC SAR limits



Fig. 7. SAR (7) versus UE location in a 5G and Release 9 system

"At higher frequencies, energy absorption is increasingly confined to the surface layers of the skin, and it is difficult to define a meaningful volume for SAR evaluation. Thus, power density (PD), rather than SAR, is currently preferred in determining compliance at above 6 GHz (FCC) or 10 GHz (ICNIRP)."

T. Wu, T. S. Rappaport, C. M. Collins, "The Human Body and Millimeter-Wave Wireless Communication Systems: Interactions and Implications," accepted in 2015 IEEE International Conference on Communications (ICC), Jun. 2015.

The 5G Appeal

The claim: doctors and scientists are against 5G

Welcome to the 5G Appeal.eu page

The 5G Appeal was prepared in 2017 by scientist and doctors who are urgently calling for the EU to halt the roll out of 5G due to serious potential health effects from this new technology. 5G will substantially increase exposure to radiofrequency electromagnetic fields (RF-EMF) on top of the 2G, 3G, 4G, Wi-Fi, etc. for telecommunications already in place. RF-EMF has been proven to be harmful for humans and the environment.

As of November 4, 2019, 261 scientists and medical doctors have signed the appeal. The 5G Appeal is still open for endorsement for scientists (PhD, professor) or medical doctors (MD. Please contact professor em. Rainer Nyberg or ass. professor Lennart Hardell. (Contact.)

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That's 261 out of 26300000. And again, it is consensus that matters, not polls or petitions.

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Cancer Outbreaks

The claim:



Parents Blame Elementary School's Cell Tower After 4th Student Diagnosed With Cancer

March 12, 2019 at 10:58 pm Filed Under: Cell Tower, childhood cancer, san joaquin county, Turlock News

(four children in three years)

Anecdote is not science, and these occurrences are purely statistical.

The incidence of childhood cancer is p=15.3/100000 per year. Ref: M. Hewitt *et al.*, National Academies Press (2003).

The probability of M students out of N getting cancer is

$$p_N(M) = \binom{N}{M} p^M (1-p)^{N-M}$$

In a given year, out of a student body of 500

prob(no students get cancer)	92.6%
prob(at least one gets cancer)	7.3%
prob(at least two get cancer)	0.27%
prob(at least three get cancer)	7.0 10-5
prob(at least four get cancer)	1.3 10-6
prob(at least five get cancer)	2.0 10-8
There are 89000 elementary schools in the USA.

In a given year:

prob(no schools have a cancer case)	0
prob(at least one school has an outbreak with 1+ cases)	100%
prob(at least one school has an outbreak with $2+$ cases)	100%
prob(at least one school has an outbreak with 3+ cases)	99.8%
prob(at least one school has an outbreak with 4+ cases)	12%
prob(at least one school has an outbreak with $5+$ cases)	0.2%

In a given year:

prob(at least one school has an outbreak with 3+ cases)	99.8%
prob(at least two schools have an outbreak with 3+ cases)	98.6%
prob(at least three schools have an outbreak with 3+ cases)	94.8%
prob(at least four schools have an outbreak with 3+ cases)	86.9%
prob(at least five schools have an outbreak with 3+ cases)	74.6%
prob(at least six schools have an outbreak with 3+ cases)	59.3%

6. NH HB 522 Charge

(3) Why have 1,000s of peer-reviewed studies, including the recently published U.S. Toxicology Program 16-year \$30 million study, that are showing a wide-range of statistically significant DNA damage, brain and heart tumors, infertility, and so many other ailments, been ignored by the Federal Communication Commission (FCC)?

FCC regulations are based on scientific consensus. Statistically speaking, contrary studies **must** exist; it is the **preponderance** of the data that must be used to decide the possible existence of an effect.

(4) Why are the FCC-sanctioned guidelines for public exposure to wireless radiation based only on the thermal effect on the temperature of the skin and do not account for the non-thermal, non-ionizing, biological effects of wireless radiation?

FCC regulations are based on scientific consensus. There are no known non-thermal effects due to non-ionizing radiation.

(5) Why are the FCC radiofrequency exposure limits set for the United States 100 times higher than countries like Russia, China, Italy, Switzerland, and most of Eastern Europe?

```
ICNRP: 10W/m<sup>2</sup> | 2.0 W/kg
FCC: 10W/m<sup>2</sup> | 1.6 W/kg
ANSI/IEEE: 200W/m<sup>2</sup> (localized)
```

Italy, Russia, China, Switzerland: 0.1 W/m²

FCC and ICNRP limits are based on consensus scientific evaluations of world literature.

NB: general peak MPE for the public is ~ 0.01 W/m^2

(6) Why did the World Health Organization (WHO) signify that wireless radiation is a Group B Possibly Carcinogenic to Humans category, a group that includes lead, thalidomide, and others, and why are some experts who sat on the WHO committee in 2011 now calling for it to be placed in the Group 1, which are known carcinogens, and why is such information being ignored by the FCC?

The <u>IARC</u> classified cell phone RFR a type 2B carcinogen [as are coffee & pickled vegetables]

(WHO's position: "To date, no adverse health effects have been established as being caused by mobile phone use.")

https://www.who.int/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-phones

IARC's reason: there was "limited evidence" for effects in humans which meets their definition of "2B".

[based on a single point in the Interphone study and Hardell studies, which IARC found flawed.]

FCC regulations are based on scientific consensus. They are not based on the beliefs of a few individuals.

(7) Why have more than 220 of the worlds leading scientists signed an appeal to the WHO and the United Nations to protect public health from wireless radiation and nothing has been done?

I cannot speak to what motivates people, but I can find 261 PhDs (out of 26 million) who will sign off on just about anything. (8) Why have the cumulative biological damaging effects of ever-growing numbers of pulse signals riding on the back of the electromagnetic sine waves not been explored, especially as the world embraces the Internet of Things, meaning all devices being connected by electromagnetic waves, and the exploration of the number of such pulse signals that will be created by implementation of 5G technology?

The particular waveform is not important: only the energy deposited in tissue averaged over time and spatial volumes.

I look forward to carefully reading the committee's final report.

I am happy to take questions.



Penetration Depth in Human Skin at Different Frequencies

T. Wu, T. Rappaport, and C. Collins, "The human body and millimeter- wave wireless communication systems: interactions and implications," in Proc. IEEE International Conference on Communications (ICC), pp. 2423-2429, 2015.