Report on National Toxicology Program's Cell Phone Study

If you take the National Toxicology Program reports on cell phone radiation (rat study and mouse study) at face value, you have to believe that cell phone radiation causes cancer in rats but not mice, and in male rats but not female rats. You have to believe that cell phone radiation is such a weak carcinogen that it only causes cancer in two to three percent of male animals and only in one species. You have to believe that after two years of continuous exposure to thermal levels of radiation the vast majority of both rats and mice were essentially normal in appearance and behavior and had completely normal blood work.

The reality is quite different and a lot messier. I have now spent days poring over the actual data on individual animals. The rats in particular were all in terrible shape at the end of the two years—all the rats, in every exposure group. Many had breathing problems, diarrhea, uncoordination, eye abnormalities, tremors, and paralysis. They developed enormous numbers of tumors, both benign and malignant. The "unexposed" groups of rats were in worse shape than the "exposed" animals and developed just as many tumors.

The "unexposed" control animals were housed adjacent to the irradiated animals in the same facility. The rooms were connected to each other by coaxial cables and "other interconnections," including common wiring that powered all the mechanical equipment, sensors and lights. The microwave transmitters were connected to the same wiring. There were common heating and air conditioning systems, and there was a common exhaust duct system connecting all the rooms that was made of metal. The microwave radiation levels were monitored but lower frequencies were not. In a reverberation chamber the radiation from the "dirty electricity" would have been amplified tremendously.

Only about 78% of the mice, and 50% of the rats survived until the end of the two years. The "unexposed" group of male rats fared the worst. Only 25 of the 90 "unexposed" male rats survived the two years. They died early of kidney failure, heart failure, and a large variety of benign and malignant tumors. Here is a sample of the causes of death in the "unexposed" group:

Animal No:	Cause of death
501	"Benign" pituitary tumor (day 642)
502	(lived to end of study)
503	Kidney failure (day 590)
504	Died of unknown cause on day 294
506	Died of unknown cause on day 655
509	Kidney failure (day 681)
510	Pancreatic cancer (day 691)
511	Kidney failure (day 580)
512	"Benign" mammary gland tumor (day 440)
513	"Benign" pituitary tumor (day 527)
514	"Benign" pituitary tumor (day 541)
515	"Benign" kidney tumor (day 654)
516	(lived to end of study)

517 Pancreatic cancer (day 677)
518 (lived to end of study)
519 Kidney failure (day 498)
520 Kidney failure (day 563)
521 Kidney failure (day 562)
522 Skin cancer (day 719)
523 (lived to end of study)

25 of 90 "unexposed" male rats lived to the end of the study.
43 of 90 male rats exposed to 1.5 W/kg lived to the end of the study.
55 of 90 male rats exposed to 3 W/kg lived to the end of the study.
43 of 90 male rats exposed to 6 W/kg lived to the end of the study.

For female rats, and for all the mice, there was essentially no difference in survival rates between the different groups of rats, regardless of their exposure levels.

All the rats and all the mice developed enormous numbers of tumors. I analyzed the rats exposed to GSM in the most detail. My numbers do not agree with the numbers in the NTP report, which underreported the numbers of tumors and malignancies. Since the numbers of tumors are essentially the same for all levels of exposure, including "unexposed," I combined all the animals together and analyzed each group of 360 animals as a unit.

Male rats exposed to GSM
360 animals
more than 821 tumors
more than 334 malignancies
278 animals with tumors (77% incidence rate)
128 animals with malignancies (36% incidence rate)

Female rats exposed to GSM
360 animals
more than 1139 tumors
more than 401 malignancies
344 animals with tumors (96% incidence rate)
123 animals with malignancies (29% incidence rate)

Male rats exposed to CDMA
360 animals
more than 836 tumors
271 animals with tumors (75% incidence rate)

Female rats exposed to CDMA
360 animals
more than 1100 tumors
345 animals with tumors (96% incidence rate)
Male mice exposed to GSM

360 animals
more than 939 tumors
320 animals with tumors (89% incidence rate)

Male mice exposed to CDMA
360 animals
more than 925 tumors
335 animals with tumors (93% incidence rate)

Female mice exposed to GSM
360 animals
more than 758 tumors
215 animals with tumors (60% incidence rate)

Female mice exposed to CDMA
360 animals
more than 713 tumors
233 animals with tumors (65% incidence rate)

"More than" means I counted each instance of "multiple" tumors as a minimum of 2 tumors. These are extraordinarily large numbers of tumors. For comparison, I looked at a couple of older studies of spontaneous tumor rates in Sprague-Dawley rats, the same type of rats used in the NTP study.

In an 18-month study, the overall tumor incidence in male rats was 34%, in female rats 58%, and in mice 26%. (J. D. Prejean et al., "Spontaneous Tumors in Sprague-Dawley Rats and Swiss Mice. *Cancer Research* 33: 2768-73 (1973)).

In a 25-month study on microwave irradiation of male rats, the incidence of benign tumors in the unexposed group was 38% and the incidence of malignant tumors was only 5%. The total number of tumors among the 100 rats was 76. (C. K. Chou, et al., "Long-Term, Low-Level Microwave Irradiation of Rats," *Bioelectromagnetics* 13: 470-496 (1992)).

The NTP tables of individual clinical observations are intriguing and suggestive, at least in rats, of an inverse dose response. In other words, the lower the dose, the worse the effect:

Male rats exposed to GSM

	"unexposed"	1.5 W/kg	3 W/kg	6 W/kg
diarrhea	16	5	3	2
abnormal breathing	30	18	11	5
lethargic	34	16	12	9
thin	42	27	18	17
nasal/eye discharge	36	32	38	22
ataxia (unsteadiness)	22	3	1	1
paralysis	4	1	0	0
hindlimb splay	1	6	4	1
ulcer/abscess	10	19	22	17
ruffled fur	47	38	31	21
eye abnormality	36	28	35	28
clonic seizures	1	0	0	0
tremors	2	2	0	0

This is reminiscent of another series of tables, published long ago, when the U.S. Embassy in Moscow was being irradiated by microwaves and embassy employees were getting cancer and complaining of unwellness. Johns Hopkins epidemiologist Abraham Lilienfeld prepared a lengthy report for the State Department titled "Evaluation of Health Status of Foreign Service and Other Employees from Selected Eastern European Posts" (July 31, 1978). His findings of an *inverse* relationship between exposure levels and symptoms were so counterintuitive that he didn't believe his own results and concluded that embassy personnel "suffered no ill effects" from the radiation. The numbers below are from Table 6.32 of Lilienfeld's report, for male embassy employees:

	Exposure Status in Moscow	
	Unexposed Rate per 1000 person-years	Exposed Rate per 1000 person-years
Fainting	1.9	2.2
Depression	8.8	3.5
Migraine	5.6	3.5
Sleepiness	2.8	3.5
Lassitude	7.4	5.3
Irritability	7.9	4.4
Nervous disorders	1.4	0.88
Anxiety	6.5	2.2
Vibrations	11.1	9.3
Intraocular pain	0.46	0.0
Sensations	2.3	1.8
Loss of Appetite	2.3	1.3
Difficulty concentrating	6.5	3.5
Memory loss	5.6	1.3
Dizziness	6.0	5.3
Finger tremor	3.7	1.8
Hallucinations	0.93	0.0
Insomnia	7.0	4.4
Neurosis	0.46	0.0
Other symptoms	3.7	3.1

The "unexposed" embassy workers had a higher incidence in 18 of the 20 symptom categories. Equally spectacular results were obtained for female embassy employees (Table 6.34). The study population was 1,827 people who had worked at the Moscow Embassy over the 24-year period of irradiation. Lilienfeld classified radiation levels below 1 $\mu W/cm^2$ as "unexposed."

Considering the fact that half the rats in the NTP study died of things like kidney failure before the end of the study and that so many of them were in poor physical shape, it is hard to believe that all their blood work was normal. Since the averaging of data always loses the details and hides the truth, I reserve judgment until I can look at the hematology data for the individual animals. That data has not yet been released by the NIH.

Arthur Firstenberg
April 12, 2018

NTP analysis – Part II: design flaws and conclusions

As I have shown in Part I of my analysis, the National Toxicology Program cell phone studies (rat study and mouse study) produced large numbers of tumors in both species. The mice had fewer tumors than the rats. However, within each species, the numbers of both benign and malignant tumors were enormous and essentially the same for every level of exposure, including "unexposed."

In Part II, I point out some serious design flaws in these studies and reach some conclusions about the meaning of the results that are much different than the conclusions reached by others.

1. Exposure levels were poorly controlled.

For the rat study, the SAR levels were stated to be 0, 1.5, 3, and 6 W/kg.
For the mouse study, the SAR levels were stated to be 0, 2.5, 5, and 10 W/kg.

Those were the *target* SAR levels. The *actual* SAR levels were all over the place. The "medium" exposure animals were often exposed to more radiation than the "high" exposure animals. Even the "low" exposure animals were sometimes exposed to more radiation than the "high" exposure animals. For example, these were the minimum and maximum exposure levels recorded during the two years for mice exposed to GSM radiation:

	Minimum	Maximum
"high"	3.290 W/kg	23.576 W/kg
"medium"	2.105 W/kg	11.918 W/kg
"low"	0.472 W/kg	4.060 W/kg

Instead of 10 W/kg, the "high" exposure mice were sometimes exposed to 23 W/kg. Instead of 5 W/kg, the "medium" exposure mice were sometimes exposed to almost 12 W/kg.

The range of exposures for the rats was even more scattered. These were the minimum and maximum levels recorded for male rats exposed to GSM radiation:

	Minimum	Maximum
"high"	0.734 W/kg	25.815 W/kg
"medium"	0.391 W/kg	10.692 W/kg
"low"	0.292 W/kg	5.732 W/kg

Instead of 6 W/kg, the "high" exposure rats were sometimes exposed to 25 W/kg. Instead of 3 W/kg, the "medium" exposure rats were sometimes exposed to 10 W/kg. The "low" exposure rats were sometimes exposed to almost 6 W/kg, which was the target level for the "high" exposure rats. This variation of exposure with time was a direct result of the constantly moving stirrers (see below), which rotated at a speed of between 1 and 50 revolutions per second, so that

the exposure level at any point in the chamber could change dramatically up to 50 times per second.

The purpose of the stirrers was to make sure that the radiation levels were uniform in space. This, however, was not achieved either. The cages at the at the top of the chamber were exposed to three to four times as much radiation as the cages at the bottom of the chamber. In an attempt to equalize the exposures, the researchers continually rotated the cages.

Despite the significant spatial variations and the enormous temporal variations, the NTP reports claim that the exposure levels were within the target range almost 100% of the time. How could that be? The answer is hidden in the definition of "target." For example, the rat study defined the "high" target level of 6 W/kg to be met as long as the actual level was anywhere from 3.79 W/kg to 9.51 W/kg. The "medium" target was met if the actual level was anywhere from 1.89 to 4.75 W/kg. The "low" target was met if the actual level was anywhere from 0.95 to 2.38 W/kg.

In other words, the exposure levels were poorly controlled and there was no clear difference between "low," "medium," and "high."

2. The "unexposed" chambers were not unexposed.

Although the chambers were described as "fully shielded," the shielding was stainless steel, which is not best, and the degree of shielding was either not measured or not reported.

In addition to the unknown degree of shielding, the different exposure chambers, as I noted in Part I, were not isolated from one another. There were multiple conductive pathways from the "exposed" chambers into the "unexposed" chambers: wiring, heating and air conditioning systems, exhaust ducts, coaxial cables, plumbing (an automated watering system supplied water to each cage via stainless steel tubes) and "other interconnections." The microwave transmitters were connected to the common wiring. Radiation was conducted over multiple paths into the all the chambers, resulting in both cell phone radiation and "dirty electricity" everywhere, including the "unexposed" chambers. In these reverberation chambers, the frequencies were amplified tremendously.

Although RF radiation between 40 MHz and 6 GHz was monitored every 20 seconds, lower frequencies were not monitored. Wired connections were filtered for microwave frequencies, but the degree of attenuation is not stated. Other conductive pathways were not filtered, and lower frequencies were not filtered.

The sources of radiation into the "unexposed" chambers were multiple:

(a) Cell phone radiation: 900 MHz and 1900 MHz. Cell phone radiation levels were monitored in every chamber every 20 seconds However, the electric field sensors that were used (ER3DV6 E-field probes) were only capable of measuring down to 2 V/m, so the reported "0.0" values in all the "unexposed" chambers only means the radiation levels were less than 2 V/m. That is the same as 1 $\mu W/cm^2$, and is a high level of exposure.

(b) Switch-mode power supplies. Each of the 18 RF antennas (one in each exposure chamber) was powered by a switch-mode power supply that converted the AC wall current to DC. Switch-mode power supplies are a notorious source of dirty electricity.

(c) Variable frequency drives. Each of the 21 chambers, including the 3 "unexposed" chambers, contained two motor-controlled "stirrers" with adjustable speed control. Variable frequency drives are another notorious source of dirty electricity.

(d) Wireless microphones. It is hard to believe, but the NTP reports state that the microphones, located in the air exhaust ducts, that monitored noise levels in each chamber, had a "design based on WL-93 microphone; Shure Brothers, Inc., Evanston, IL." The WL-93 model is a wireless microphone.

(e) Modulation frequencies from the cell phone transmitters. Since the transmitters were powered by DC current, the cell phone modulation frequencies would have traveled through the building's wiring and along the multiple other connections into the "unexposed" chambers.

(f) Modulation frequencies from the stirrers. The antenna in each of the 18 exposure rooms was directed toward one of the two "stirrers." The stirrers were metallic, reflective contraptions that rotated at a variable speed between 1 and 50 rpm. Their purpose was to "mix" the radiation in the chamber so as to produce a uniform power level. First of all this did not work (see above: actual radiation levels in individual chambers varied spatially up to 4-fold and temporally up to 35-fold). Secondly, this modulated the radiation at additional frequencies of 1 to 50 Hz, which further confounded the results in the "exposed" chambers and leaked via multiple paths into the "unexposed" chambers.

3. The hematology and blood chemistry results were averaged and outlying values were eliminated.

At 14 weeks into the studies, blood from some of the animals was drawn and analyzed, and then the results were all averaged together. The researchers virtually admitted that the results were abnormal. Hematology and clinical chemistry, they wrote, "have typically skewed distributions." Further, they wrote, "implausible values were eliminated from the analysis." One way to hide abnormal data is by throwing out the most extreme values and then averaging the rest.

As of today, the NIH has not released the individual hematology and clinical chemistry results for any animals.

4. The animals were fed irradiated food and had irradiated bedding.

The safety of irradiated food has long been controversial. Reported effects of irradiated food include premature death, genetic damage, reproductive problems, residual radioactivity, immune system dysfunction, internal bleeding, organ damage, tumors, blood disorders, nutritional deficiencies and stunted growth. (Public Citizen, "Questioning Food Irradiation: A History of Research into the Safety of Irradiated Foods," Washington, DC, April 2003). This was another completely unnecessary confounding factor that confused the interpretation of the results.

5. Conflicts of interest: The test facility was designed, maintained and monitored by the telecommunications industry.

The IT'IS Foundation designed, built, maintained, measured, and monitored the chambers and the exposure system throughout the studies. It installed all system hardware and software. The IT'IS Foundation is funded in large part by telecommunications companies, including the CTIA, the GSM Association, AT&T, Deutsche Telecom, Nokia, Qualcomm, Samsung, Motorola, Mitsubishi, Ericsson, Vodafone, DoCoMo, Intel, TCT Mobile (Alcatel and Blackberry), Sunrise Communications, Panasonic, SONY, Safran (French aerospace and defense company), Phonak Communications, LG Electronics, Cisco Systems, the Association of Radio Industries and Businesses, and the Foundation on Mobile Communications (Switzerland). The full lists of sponsors and partners are here: https://www.itis.ethz.ch/who-we-are/funding/ and https://www.itis.ethz.ch/who-we-are/partners/.

The technical aspects of the exposure system are not in the open literature and are not available from the NIH. They were published in *IEEE Transactions on Electromagnetic Compatibility*, Vol. 49, No. 4, August 2017, pp. 1041-1052, and I had to purchase the article in order to read it. The title is "A Radio Frequency Radiation Exposure System for Rodents Based on Reverberation Chambers." Of the 11 authors, 4 work for the IT'IS Foundation, 1 used to work for the IT'IS Foundation, one works for Siemens Mobility, one has worked for Motorola, and one has worked for the Mobile Telecommunications and Health Research Programme of the U.K.

Conclusions

These were poorly designed, poorly controlled studies conducted by scientists with blatant conflicts of interest.

There were no unexposed groups of animals. There were large numbers of tumors at every exposure level: 1 $\mu W/cm^2$, 5 mW/cm^2, 10 mW/cm^2, and 20 mW/cm^2 (rats); 1 $\mu W/cm^2$, 4 mW/cm^2, 8 mW/cm^2, and 16 mW/cm^2 (mice).

In the Chou et al. (1992) study the malignant tumor incidence in unirradiated male rats was 5%, and in irradiated rats was 18%. In the NTP study it was 36%.

In the Chou et al. study there were 76 tumors among 100 unirradiated male rats, and 116 tumors among 100 irradiated male rats. In the NTP study there were 228 tumors per 100 male rats.

Chou et al. found that RF radiation at an SAR of 0.4 W/kg causes cancer. The NTP study found that RF radiation, both at much higher and much lower SARs, causes cancer.

Despite this being a poorly designed study it is evidence that RF radiation, at all exposure levels, causes cancer. Not just a tiny number of schwannomas of the heart, but large numbers of all types of cancer. There is no basis on which to conclude that the schwannomas were caused by RF radiation but the other tumors were not. The most significant difference between the NTP (2018) study and the Chou et al. (1992) study is the multitude of other sources, types, and frequencies of radiation that the NTP animals were exposed to. There were no stirrers,

reverberation chambers, switch-mode power supplies, variable frequency drives, wireless microphones, cell phone modulation frequencies, irradiated food, or irradiated bedding in the 1992 study, just a single pulsed 2,450 MHz signal. It caused less cancer because it exposed the animals to less radiation. By less radiation I don't mean less power.

It is not the power level that does the harm. It is the degree of coherence, type and depth of modulation, wavelength, number of frequencies, number of signals, bandwidth, shape of the waves, pulse height, pulse width, rise and fall time, and other properties of the radiation. The unimportance of power levels for effects other than heat has been shown many times. In Salford's studies[1] the lowest power levels caused the most leakage in the blood-brain barrier. Blackman,[2] Bawin,[3] Dutta,[4] Schwartz,[5]and Kunjilwar,[6] all in different laboratories, found that calcium efflux from neural and cardiac cells occurred at specific frequencies and exposure levels and did not increase with power. In Dutta's study a 3,000-fold decrease in power caused a 4-fold *increase* in calcium efflux. Sadchikova[7,8] and her Soviet colleagues found that workers exposed to the lowest power levels suffered more often from radio wave sickness. Belyaev[9] found that genetic effects occurred at specific frequencies and the magnitude of the effect did not change with power level over 16 orders of magnitude.

My conclusion from the NTP studies is that RF radiation causes a lot of both malignant and benign tumors at every exposure level. The assumption that there is a dose response, i.e. higher power levels cause more cancer, is proven wrong.

The assumption that wireless technology can be made safe by reducing the power is proven wrong.

Arthur Firstenberg
April 20, 2018

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