Following are my comments on the draft NTP study examining the biological effects of radiofrequency radiation (RFR) on rodents.

PERSONAL BACKGROUND

I received a Ph. D. in Aerospace and Mechanical Sciences from Princeton University in 1967, and subsequently worked for Bell Laboratories, Department of Energy, Office of Naval Research, and MITRE Corp. I have published over 200 peer-reviewed articles, served as Guest Editor of four journal Special Issues since 1994, obtained two text mining system patents, and presently am a Research Affiliate at Georgia Institute of Technology.

I have published on numerous medical topics in the peer-reviewed literature, including:

- potential treatments for Multiple Sclerosis, Parkinson's Disease, Raynaud's Phenomenon, Cataracts, SARS, Vitreous Restoration, and Chronic Kidney Disease;
- potential causes of Chronic Kidney Disease and Alzheimer's Disease; and
- potential impacts of Electromagnetic Fields on health.

I am listed in:

- Who's Who in America, 60th Edition (2006);
- Who's Who in Science and Engineering, 9th Edition (2006), and
- 2000 Outstanding Intellectuals of the 21st Century, 4th Edition, (2006).

COMMENTS ON UTILITY OF NTP RFR STUDY RESULTS

The purpose of the study is unclear to me. Is it just another one of thousands of studies to generate biological impact data resulting from RFR exposure, or is it a study that could help decision-makers advance the public safety by avoiding potential RFR damage? If the latter, then the issue of the frequency selected becomes important. 2G using ~900MHz was introduced about twenty-five years ago, with CDMA coming perhaps five years later. A credible ten year twenty-five million dollar biological effects experiment using 900MHz RFR (the present NTP study being discussed) would have made some sense if conducted in the 1980s by the Federal government, when cellular network deployment decisions were being made.

Why was 900MHz selected decades after the horse had left the barn? Why weren't the much higher frequencies characteristic of 5G selected for experimental purposes? The 5G frequency results, had they appeared at the present time, could conceivably have had some effect on the decision to implement 5G. Obviously, testing both 900MHz and 5G frequencies would have been even more desirable:

- we could estimate the damage that has already been done from 2G/3G/4G deployment, and
- we could estimate the damage we can expect from 5G deployment.

COMMENTS ON NTP RFR STUDY CONCLUSIONS

Some conclusions from the rat study
(https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf)

are shown in Appendix 1. There were additional cancers in exposed rats, but the seriousness of the situation does not convey to the reader. Statements like "There was equivocal evidence of carcinogenic activity" will be used/are being used by cell phone proponents to convince consumers that the evidence of harm is not conclusive. On the other hand, the evidence of some additional cancers has been used by cell phone opponents to convince consumers of the demonstrated danger from wireless radiation. Each of the two opposing groups receives a few crumbs from the results of this study!

Ambiguous results such as those above are exactly what is needed for 5G to be implemented with minimal obstruction. If I were in the government and wanted to design a study and obtain results that would give the appearance of objectivity and would not impede the accelerated implementation of 5G, ***then the study that was designed by the NTP and the results that were obtained from the study are exactly what I would have wanted***.

COMMENTS ON ANIMAL EXPERIMENT DEFICIENCIES

In our recent monograph on Preventing and Reversing Alzheimer's disease (https://smartech.gatech.edu/handle/1853/59311), we stated the following with regard to animal experiments:

"Additionally, results from animal testing (which could be long-term from the perspective of many short-lived animals used in testing) do not necessarily translate to human outcomes. First, there is a species difference, and impacts on one species do not necessarily carry over to the same types of impacts on another species. Second, ***laboratory animals are raised in relatively pristine environments, and subjected to a very few toxic substances during studies on disease contributing factors. Conversely, humans experience many of the contributing factors identified in reference [6], and the synergy from these combinations would not have been replicated in the laboratory animal testing***."

The latter issue is particularly relevant with respect to the NTP study. The rats were housed in reverberation chambers for up to two years, and subjected to RF exposure protocols at a frequency of 900MHz. One type of rat was used: Sprague Dawley.

The environment had no relevance to human exposures. There was no air pollution, no water pollution, no fast foods, no toxic chemicals, no toxic exposures to other types of ionizing and non-ionizing radiations, etc. Why is the absence of toxic exposures other than RFR relevant to an experiment purportedly examining the health effects of RFR?

SYNERGETIC EFFECTS

Our recent book chapter on health effects from non-ionizing radiation combined with other stimuli (http://stip.gatech.edu/wp-content/uploads/2017/03/371048_1_En_4_Chapter_OnlinePDF.pdf)

contains many examples where, for the non-ionizing parameters selected (radiation frequency, duration, intensity, etc),

- the radiation delivered in isolation may have had little or no effect,
- the other stimuli delivered in isolation may have had little or no effect, but
- the combination of the radiation and the other stimuli had a major effect.

Combination of toxic stimuli is the real-world of human exposure, not two years in a pristine reverberation chamber exposed to one toxic stimulus.

I provide some specific examples of these synergetic effects from our book chapter in Appendix 2, both for RF and for ELF (~60Hz) frequencies. There were over a hundred such examples in our book chapter, perhaps another 400 examples we retrieved from Medline but did not include in the book chapter for space considerations, and a few hundred other examples that were either not retrieved with the query used or entered the biomedical literature since the closing date for the chapter.

UNDER-REPORTING POTENTIAL DAMAGE FROM RFR EXPOSURE

Based on the above, the NTP study results should be viewed as the tip of the iceberg of potential RFR damage to health. If one of the main functions of RFR exposure is that of promoter, or enabler, or accelerator, then concurrent exposures to other toxic stimuli are ***required*** to show the extent of damage possible from RFR. If future experiments include other frequencies and signal structures, other rodent species, and, most importantly, other potentially toxic stimuli in combination with the RFR, I would expect the damage observed to skyrocket!

Frankly, it is not clear to me why the NTP study did not include one or two groups of rodents that were exposed to RFR and one other toxic stimulus that had been shown by past studies to contribute to a strong synergetic effect with RFR. Was this because of lack of resources (time and money), an oversight, or was it deliberate?

More generally, can we expect ANY Federal government organization to generate results that will diametrically oppose the unified front being promulgated by other higher-level Federal government entities? In the present case, the FCC (in the past and present Administrations) has been promoting the accelerated implementation of 5G, and this is supported almost unanimously by Congress and other major affected Administration Departments. If experiments were conducted that simulated more closely the real-world situation of concurrent exposures to RF and myriad other toxic stimuli, and if the results paralleled the real-world findings (reported in our book chapter) of unmistakable excess cancers and other damage due to cell tower proximity and heavy cell phone use, ***the other Federal agencies promoting 5G accelerated implementation would be left in an untenable position!***

APPENDIX 1 - CONCLUSIONS FROM NTP STUDY ON RATS

"Under the conditions of this 2-year whole-body exposure study, there was some evidence of carcinogenic activity of GSM-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma in the heart. The incidences of adenoma or carcinoma (combined) in the prostate gland, malignant glioma and benign or malignant granular cell tumors in the brain, adenoma of the pars distalis in the pituitary gland, pheochromocytoma (benign, malignant, or complex combined) in the adrenal medulla, and pancreatic islet cell adenoma or carcinoma (combined) may have been related to cell phone RFR exposure. There was no evidence of carcinogenic activity of GSM-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats administered 1.5, 3, or 6 W/kg. There was some evidence of carcinogenic activity of CDMA-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma in the heart. The incidences of malignant glioma in the brain, adenoma of the pars distalis in the pituitary gland, and adenoma or carcinoma (combined) of the liver may have been related to cell phone RFR exposure. There was equivocal evidence of carcinogenic activity of CDMA-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats based on the incidences of malignant glioma in the brain and pheochromocytoma (benign, malignant, or complex combined) in the adrenal medulla."

APPENDIX 2 - EXAMPLES OF COMBINED EFFECTS OF NON-IONIZING EMF AND OTHER TOXIC STIMULI

(numbered references are those in the book chapter)

a). "adverse effects of gamma-rays on cellular functions are strengthened by EMF" [44]

b). "synergistic effect from RF exposure preceding the mutagen mitomycin C in an investigation of 954-MHz waves emitted by the antenna of a GSM base station" [45]

c). ""ELF MFs have been reported to enhance the effects of known carcinogenic or mutagenic agents in a few animal studies and in several in vitro studies [47]"

d). "When the two types of radiation were delivered in a combination the sequence of delivery was of a significant importance. Antagonism of the effects was noted when microwave radiation was delivered prior to gamma-radiation. The effect was synergistic when the exposure to microwaves followed gamma-irradiation." [49]

e). "MF exposure significantly increased mammary tumor development and growth in SD1 [one substrain of Sprague-Dawley DMBA-exposed rats] but not SD2 [another substrain of Sprague-Dawley DMBA-exposed rats obtained from the same breeder] rats. These data indicate that the genetic background plays a pivotal role in effects of MF exposure." [71]

This example also shows how results can change/be manipulated by choice of test species. In fact, ***there are many ways the outcome of such experiments could be pre-determined by the "right' choice of experimental parameters, including the test animal species, the frequencies and signal patterns selected, and whether any potentially toxic stimuli are administered in parallel with the RF radiation***.

f). "872 MHz CW RF radiation at 5 W/kg might enhance chemically induced ROS production and thus cause secondary DNA damage" [121];

g). "The effects were more pronounced after treatment with both Cd and EMF than at the treatment with each exposure alone..... This work concluded that combined exposure to Cd and EMFs might increase the risk of plasma damage via enhancing free radical generation and protein oxidation." [149]

h). "microwave radiation for a significant acceleration of the development of benzopyrene-induced skin cancer and in shortening of life span of the tumor-bearing hosts "[66]

i). "solvents, lead, and pesticides/herbicides were only associated with glioma in workers also exposed to moderate or high levels of ELFMF [68]"

j). "long-term exposure of DMBA-treated female Sprague-Dawley rats in an alternating MF of low flux density promotes the development and growth of mammary tumors, thus indicating that MF exposure exerts tumor-promoting and/or compromoting effects" [70]

k). "Although no association was found for childhood leukemia in relation to measured ELF or static magnetic fields alone, an increasing trend of leukemia risk with measured ELF fields was found for subjects within these static field.....findings suggest that the risk of childhood leukemia may be related to the combined effects of the static and ELF magnetic fields."[76]