Animal studies of exposures to radiofrequency fields

J Mark Elwood, Andrew W Wood

We thank Dr Kelly for his interest in our paper on health effects of radiofrequency fields, and we agree that the animal studies by the US National Toxicology Program (NTP) are important. However, the interpretation is by no means simple. The studies in rats assessed lifetime exposure to two modulations of 900MHz radiofrequency fields (RF), GSM and CDMA, each at three dosages.1 The lowest dose was 1.5W/kg, designed to be similar to the maximum dose allowed by standards, and higher doses of 3 and 6W/kg were used. Earlier studies showed 10W/kg to be often lethal, due to heating effects. Many types of tumours were assessed. There was a significant increase in a very specific tumour, cardiac malignant schwannoma, in male rats, with exposure to the highest dose, 6W/kg of GSM or CDMA, with no increase with exposures at the other two doses. There were no significant increases in female rats, or in male or female mice.2 Cardiac schwannomas are exceedingly rare in humans: 18 cases were reported worldwide up to 2018.3 The logic in studying them is that they may be analogous to vestibular schwannoma (acoustic neuromas) in humans, as they have similar histology. But schwannomas occur at many sites in rats, and another logical comparison is with the incidence of all malignant schwannoma; but the NTP studies showed no significant increases in total schwannoma, or in schwannoma specific to any other site, even in male mice with the highest RF dose used. Brain lesions, malignant glioma and glial cell hyperplasia, are more clearly analogous to human brain tumours; there were no statistically significant excesses in any dose category either male or female rats, or in mice.

Several difficulties in interpretation exist. A striking result is that in the control group of 90 male rats, only 28% survived through the two years of the experiment, compared to 48–68% in the six exposure groups. As each exposure group was compared to this same control group, this difference affects every comparison. A different statistical method was used in the 2018 report, compared to the 2016 results,4 to partially adjust for this. The NTP conclude that this survival difference was due to a lower rate of kidney disease in RF exposed animals, which they say could be a protective effect.

A key issue is that of performing many statistical tests. Very many outcomes were assessed. Statistical significance was based on a P=<0.05 criterion, but one-sided, and no adjustment for multiple testing was done. Over 200 endpoints were assessed, each in two sexes, two modulations and three dosages: over 1,000 comparisons, so many ‘significant’ results would occur by chance. The focus of the NTP methods is to identify possible harmful agents, while accepting frequent false positives, on the basis that the findings will be checked by further research. In the rat studies, there were several other positive results; there were also ‘significant’ decreases in pituitary and mammary adenomas in some groups of animals. The NTP reports results in their summary often ignoring statistical tests; for example in their summary they say “tumours of the brain were also considered to be related to exposure” although there were no significant results for GSM, and only one ‘significant’ trend test for CDMA, at P=0.04.

There were significantly increased risks of pheochromocytoma at the lower two dose levels of GSM in male rats and at the lowest dose of CDMA in females; but there were no increases at the highest exposures, and no dose-response.

It is usual practice in interpreting animal carcinogenesis studies for application to humans to require animal evidence from at least two species,5 so the NTP used both rats and mice. The results for mice exposed...
Results on brain and heart tumours, but not yet on other outcomes, are also available from studies of lifelong exposures to rats from the Ramazzini Institute in Italy. These used GSM at 1.8 GHz, at three dosages, 0.001, 0.03 and 0.1W/kg, all much lower than those used by the NTP, and closer to the dosages of human exposure. No significant increases in meningeal tumours or in glial hyperplasia or malignant tumours were seen. There was a statistically significant excess of cardiac schwannoma in male rats at the highest exposure dose (0.1W/kg), with no significant excesses at lower doses or in females; for both sexes combined, there were no significant increases and the highest rate was at the lowest dose used. The increase in cardiac schwannoma at 0.1W/kg is in contrast to the NTP results, which showed no significant increases at two much higher dosages, whereas the single NTP result of an increase was seen at 60 times higher dose.

Thus there are many issues involved in the interpretation of the NTP and Ramazzini animal studies. There are contrasting opinions on what the results mean, and particularly in their relevance to humans. So, in our article we cited the studies but were cautious in interpreting them. Dr Kelly has usefully drawn attention to these important studies; but they are not simple to interpret.

Competing interests:
Nil.

Author information:
Mark Elwood, Professor of Cancer Epidemiology, School of Population Health, University of Auckland, Auckland; Andrew W Wood, Professor of Biophysics, School of Health Sciences, Swinburne University of Technology, Melbourne, Vic 3122, Australia.

Corresponding author:
Mark Elwood, School of Population Health, University of Auckland, Private Bag 92019, Auckland 1142.
mark.elwood@auckland.ac.nz

URL:
REFERENCES:


8. Hardell L, Carberg M. Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. Int J Oncol 2019; 54(1):111–127.

9. Melnick RL. Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ Res 2019; 168:1–6. doi: 10.1016/j.envres.2018.09.010. Epub@2018 Sep@20.:1-6.