Radiofrequency (RF) Sickness in the Lilienfeld Study: An Effect of Modulated Microwaves?

ANA G. JOHNSON LIAKOURIS
Twin Streams Educational Center, Inc.
Carrboro, North Carolina

ABSTRACT. There is a controversy among professionals regarding whether radiofrequency radiation sickness syndrome is a medical entity. In this study, this controversy was evaluated with a methodology adapted from case studies. The author reviewed U.S. literature, which revealed that research results are sufficiently consistent to warrant further inquiry. A review of statistically significant health effects noted in the Lilienfeld Study provided evidence that the disregarded health conditions match the cluster attributed to the radiofrequency sickness syndrome, thus establishing a possible correlation between health effects and chronic exposure to low-intensity, modulated microwave radiation. The author discusses these health effects relative to (a) exposure parameters recorded at the U.S. Embassy in Moscow and (b) the Soviet 10-microwatt safety standard for the public. Given the evidence, new research—with current knowledge and technology—is proposed.

Literature Review of Human Studies

THE RADIOFREQUENCY RADIATION (RF) SICKNESS SYNDROME is a controversial medical entity in the United States. It is a systemic human response to chronic low-intensity RF exposure, identified in the 1950s by Soviet medical researchers,[1] who named it *neurotic syndrome*. Some of the symptoms are headache, ocular dysfunction, fatigue, dizziness, and sleep disorders.[2] In the United States, professionals have largely dismissed reports about this syndrome, citing it as being subjective and indicating that it results from an awareness bias; nonetheless, RF sickness syndrome has been legally recognized as "microwave radiation sickness."[3] Only in Soviet medicine[1–4] are the following clinical manifestations accepted: dermographism, tumors, hematological alterations, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment (among others). In 1978, Justesen et al.[5] recognized that Soviet research had "ecological validity," but they did not endorse the safety standard for the public (i.e., 10 microwatts [mW]). In Mitchell's 1985 review,[4] he confirmed that Soviet researchers considered the existence of neurological manifestations to be proven. In the United States, professionals simply dismissed the syndrome.

The available literature in the United States contains information in support of the RF sickness syndrome as a medical entity. Occupational studies[1,2,7–11,17] conducted between 1953 and 1991 *and* clinical cases[12–15] of acute exposure between 1957 and 1993 offer substantive evidence for the syndrome. Soviet researchers contend that the syndrome is reversible at early stages, but maintain that it is lethal over time.[16] The most valid criticism is the lack of study results that provide accurate exposure parameters linking cause and effect.

Radiofrequency Radiation Sickness in the Lilienfeld Study

The Johns Hopkins Foreign Service Health Status Study[17,18] (i.e., Lilienfeld Study) contains both medical data and properly recorded exposure parameters. To date, however, investigators have not evaluated the data, relative to RF sickness syndrome. Investigators conducted the Lilienfeld Study during the period of irradiation between 1953 and 1976 in response to the microwave irradiation of the U.S. Embassy in Moscow.

In the literature published in the United States, investigators acknowledged that elevated lymphocyte counts and protozoan intestinal diseases were the only statistically significant illnesses that occurred in Moscow Embassy personnel (versus controls). In the study investigators concluded that, at the time of analyses, there was no convincing evidence that directly implicated exposure to microwave irradiation in the causation of any adverse health effects.

It should be noted, however, that in the Lilienfeld Study, other higher and statistically significant effects, relative to controls, were not accounted for.[18] Four of the effects are clinical manifestations that the Soviets have attributed to RF sickness: (1) dermographism (i.e., psoriasis, eczema, and inflammatory and allergic skin problems); (2) neurological (i.e., diseases of the peripheral nerves and ganglia among males); (3) reproductive (i.e., problems during pregnancy, childbirth, and puerperium); and (4) tumors (benign among men, malignant among women). Other reviews of the Lilienfeld Study have contained information about additional hematological changes that occurred among the embassy personnel.[9–19] Three of the effects are mood alterations attributed to the syndrome: (1) irritability; (2) depression; and (3) loss of appetite. Two are functional deficits also attributed to the syndrome: (1) concentration difficulties and (2) refractive eye problems. The results of past and current research[20,21] have verified neurological effects resulting from microwaves that the Soviets attributed to the syndrome. All of these confirm the presence of RF sickness syndrome.

The recorded[18–22] exposure parameters were continuous-wave, broad-band, modulated microwave RF radiation. The frequency range was between 0.6 and 9.5 GHz. Exposures occurred 6–8 h/d, 5 d/wk. Each modulation (i.e., phase, amplitude, and pulse) was transmitted for only 48 h (or less) at a time. The average exposure per individual was 2–4 y. The intensity range was between 0.002 and 0.028 mW/cm^2. Intensities were 1 000 times below the safety guidelines proposed in the United States,[8] but the range met Soviet safety standards for the public—a fact that shifts attention to the properties of the exposure parameters.

The best match for the parameters[23–25] is given by the Soviet remote-sensing radar system for medical applications, described by Lin.[23] The exposures recorded at the U.S. Embassy were within the ranges of those produced by this radar system. Average power densities between 1 mW/cm^2 and 1 miliwatt/cm^2 were sufficient for the remote recording of physiological data. Given that Soviet physicians were instrumental in setting the 10-mW standard,[5] an implicit knowledge is evinced: the modulations capable of eliciting biosignals[26] from specific biological sites have key significance. Thus, we can propose both (a) that significant adverse health and behavior effects, like those found in the Lilienfeld Study, can be attributed to chronic exposure to low-intensity, appropriately modulated microwave radiation; and (b) that such a link can be verified empirically. In 1995, the U.S. Environmental Protection Agency and the National Council on Radiation Protection stated the need to formally address the health hazards of modulated RF radiation.[27]

Conclusion

The evidence from the literature review, as well as from the Lilienfeld Study, support the RF sickness syndrome as a medical entity. The evidence also calls for new research in which current biomedical engineering knowledge of biosignal processing and instrumentation are used.

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Requests for reprints should be sent to Ana G. Johnson Liakouris, Ph.D., Twin Streams Educational Center, Inc., 243 Flemington St., Chapel Hill, NC 27514.

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References

1. Silverman C. Nervous and behavioral effects of microwave radiation in humans. Am J Epidemiol 1973; 97(4):219–24.
2. Hill D. Human studies. In: Biological Effects of Radiofrequency Radiation. U.S. EPA-600/8-83-026F. Research Triangle Park, NC: U.S. Environmental Protection Agency, 1984; pp 112–21, sect. 5–10.
3. The New York Appellate Court. Relying, in part, on the studies performed for the United States government by Milton Zaret, recognize an occupational disease identified as "microwave radiation sickness." See Yannon v. New York Telephone Co., 450 NYS 893 (App Div, 1982; Appeal denied, 57 NY2d 726 [Ct of Appeals, 1982]).
4. Mitchell CL. Soviet research on microwave-behavior interactions. In: Monahan J, et al. (Eds). Behavioral Effects of Microwave Radiation, 1985; pp 1–8, U.S. FDA 85-8238.
5. Justesen D, Guy A, Opschuk J, et al. Research on health effects of nonionizing radiation. United States House of Representatives: Hearing Committee on Science and Technology, July 12, 1978. No. 52-3620, pp 356–66, 1979.
6. Matanoski G. Epidemiological studies of nonionizing radiofrequency exposures. In: Summary and Results of the April 26–27, 1993, Radiofrequency Radiation Conference. EPA 402-R-95-011. Research Triangle Park, NC: U.S. Environmental Protection Agency, 1985; vol 2.
7. McRee DI. Environmental aspects of microwave radiation. Environ Health Perspect 1972; 2:41–53.
8. Steneck NH, Cook HJ, Vander AJ, et al. The origins of U.S. safety standards for microwave radiation. Science 1980; 6:1230–37.
9. Goldsmith JR. Incorporation of epidemiological findings into radiation protection standards. Public Health Review 1992; 19:1991–92.
10. McLees BD, Finch ED. Analysis of reported physiological effects of microwave radiation. Advance Biol Med Phys 1973; 14:163–23.
11. Isa A, Noor M. Nonionizing radiation exposure causing ill health and alopecia arcata. Med J Malaysia 1991; 46(3):235–38.

12. McLaughlin JT. Tissue destruction and death from microwave radiation (radar). Calif Med 1957; 5:336–39.
13. Williams R, Webb T. Exposure to radiofrequency radiation from an aircraft radar unit. Aviat Space Environ Med 1980; 51:1243–44.
14. Castillo M, Quencer R. Sublethal exposure to microwave radar. JAMA 1988; 3:355.
15. Microwave News. Award for Worker Fired after Radar Accident. March–April 1993, p. 13.
16. Tolgskaya MS, Gordon AV. Pathological Effects of Radio Waves. New York: Soviet Science Consultants Bureau, 1973; pp 133–37.
17. Lilienfeld AM, Tonascia J, Tonascia S. et al. Foreign Service Health Status Study. Final report contract no. 6025-619037 (NTS publication PB-288163). Washington, D.C.: Department of State, 1978.
18. United States Senate. Microwave Irradiation of the U.S. Embassy in Moscow. Committee on Commerce. Science and Transportation. 96th Congress, 1st session, April 1979; pp 1–23.
19. Goldsmith JR. Epidemiologic evidence of radiofrequency radiation (microwave) effects on health in military, broadcasting, and occupational studies. J Occup Environ Health 1995; 1(1):47–57.
20. Frey AH. Behavioral biophysics. Psycholog Bull 1965; 63(5): 332–37.
21. Vander Vorst A, Teng J, Vanhoenacker D. The action of microwave electromagnetic fields on the nervous system. J Int Antennes 1991; pp 11–119.
22. Microwave News. Microwaves in Moscow. 1981; January, p 1.
23. Lin JC. Microwave sensing of physiological movement and change: a review. Bioelectromagnetics 1992; 13:557–65.
24. Daniels DJ. Surface penetrating radar for industrial and security applications. Microwave J 1994; 12:68–82.
25. Flemming MA, Mullins FH, Watson AWD. Harmonic Radar Detection System. In: IEEE Conference Proceedings 155, Proceedings Radar-77. 1977; pp 552–54.
26. Cohen A. Biomedical signals: origin and dynamic characteristics. In: Bronzino JD (Ed). Biomedical Engineering Handbook. IEEE Press and CRC Press, 1995; pp 805–27.
27. Summary and Results of the April 26–27, 1993, Radiofrequency Radiation Conference. I. Analysis of Panel Discussions. EPA 402-R-95-009. Research Triangle Park, NC: U.S. Environmental Protection Agency, March 1995; p 40.

Letter to the Editor

To the Editor.—The following update is offered on behalf of Jiang Xin-Min, et al., authors of the following study that appeared in the November/December 1997 (Vol. 52, No. 6 [pp 399-408]) issue of the *Archives of Environmental Health*: "Dynamics of Environmental Supplementation of Iodine: Four Years' Experience of Iodination of Irrigation Water in Hotien, Xinjiang, China."

(1) Dr. Chen Rung also contributed to this study; therefore, Dr. Chen Rung's name is hereby added to the list of those who authored this study.

(2) **Figure 1.** Figure 1, which originally appeared on page 201 of the aforementioned issue and which reflected the fate of iodine dripped in 1992 and 1993 in Long Ru and in Bakechi (1993 only), is updated to include data from 1996 in Figure 1 (p 238). If Figure 1 is examined from the top down, we find that the median urine iodine excretion of women of childbearing age in Long Ru was 55 μg/l (n = 36) in April 1996—after the last dripping in 1993; we determined the excretion before further iodine dripping was done (inadvertently) in June 1996. In Bakechi, in June of 1996, with no dripping after 1993, the median urine iodine in women of childbearing age was 105 μg/l (n = 30). Thus, in both townships urinary iodine in women increased during the third year after dripping.

In the second part of Figure 1, 1996 wheat and cabbage crops in Bakechi contained iodine concentrations that were decreased from 1995 levels, but levels remained three-fold greater than baseline levels (data not available for Long-Ru).

In the third part of Figure 1, iodine content was dramatically increased in thyroid glands of sheep (4 y of age at slaughter, n = 4 in each township) to 28 000 μg/100 g. (In comparison, the average iodine concentration in human thyroid glands in the United States is approximately 70 000 μg/100 g.) This increase may have resulted from the marked increase in iodine availability during the preceding 3 y; it may be compared with the higher, but much more modest, concentrations in urine iodine in women (above).

Finally, soil iodine concentrations increased modestly, without the spike seen after earlier drippings, in Long Ru, after further dripping (80 kg of potassium iodate) in June 1996 (Fig. 1, bottom). Soil iodine concentration was stable in Bakechi, which had no more dripping.

(3) **Figure 2.** Figure 2, which originally appeared on page 402 of the *Archives of Environmental Health* (urinary iodine concentrations in childbearing-age women in Long Ru in May 1994 [i.e., 2 y after the first dripping and 1 y after the second dripping]), is also updated, as shown on page 239 herein. The black bars indicate the proportion of the control sample that had urinary iodine concentrations within the given ranges before dripping (median = < 10 μg/l—the lower limit of detection). The open bars indicate the percentage of the test group in given ranges (median = 49 μg/l) in 1994, 1 y after the last dripping. The dotted bars indicate the distribution of urinary iodine concentrations in April 1996 (median = 55 μg/l), before any further dripping occurred.

G. Robert DeLong
Duke University Medical Center and Health System
Division of Pediatric Neurology (Box 3936)
Durham, NC 27710

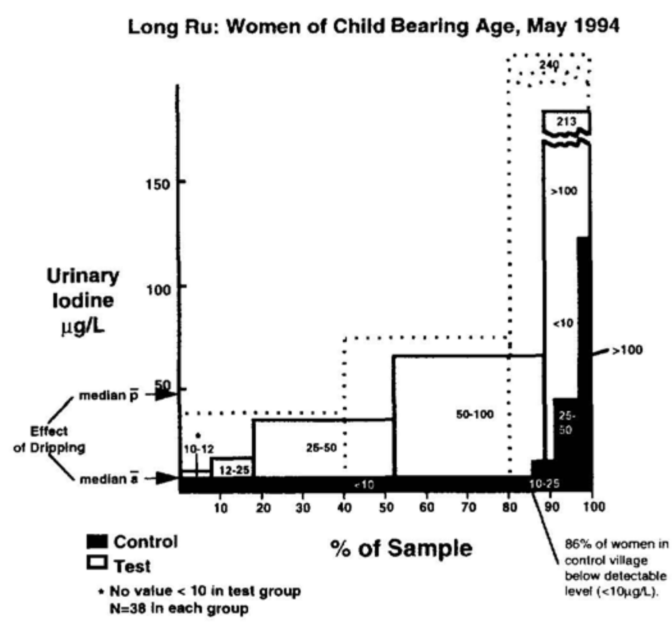

Fig. 2. Urinary iodine concentrations (mg/l) in childbearing-age women in Long Ru (updated).