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A CLINICAL STUDY OF THE RESULTS OF EXPOSURE OF LABORATORY PERSONNEL TO RADAR AND HIGH FREQUENCY RADIO¹

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Because of the rapid development and use of radar and high-frequency radio in recent months, and the inquiries that have been made to the Naval Research Laboratory and the Bureau of Medicine and Surgery, it is thought advisable to present the clinical findings that are available at this time.

For the past 12 months we have been able to observe personally the civilian personnel connected with the experimental radar work at the Naval Research Laboratory. These individuals have been working continuously, day after day, and sometimes day and night, with the equipment, and their period of association with it varies from 2 months to 9 years. (See table 1.)

TABLE 1.—Periods of exposure of laboratory personnel

Case No.	Months on duty at Naval Research Laboratory	Months exposed to radar	Average exposure during 8-hour shift (hours)	Case No.	Months on duty at Naval Research Laboratory	Months exposed to radar	Average exposure during 8-hour shift (hours)
1	12	12	3-4	24	18	18	5-6
2	14	14	3-4	25	14	14	3
3	9	3	3-4	26	32	32	8
4	14	14	1-2	27	17	17	1
5	52	52	4	28	12	12	1
6	18	18	2-3	29	12	12	2-3
7	24	24	3-4	30	15	15	1
8	54	48	4	31	9	9	0-1
9	12	12	3-4	32	12	12	3
10	12	12	8	33	9	6	1-2
11	24	24	8	34	18	18	1-2
12	42	42	1-2	35	12	12	4
13	19	19	3-4	36	30	30	4-5
14	6	6	4-5	37	29	29	1
15	2	2	0-1	38	12	12	9
16	10	10	6	39	9	9	5
17	10	10	3	40	12	33	4
18	24	24	4	41	5	5	6
19	5	3	3	42	30	30	6
20	33	33	8	43	14	14	6
21	13	13	2-8	44	12	12	6
22	20	20	8	45	192	108	6
23	18	18	3-4				

Approximately 8 months ago the Naval Research Laboratory was requested to furnish data to the Bureau of Ships as to whether or not this equipment gave off any harmful radiations, and if so, what they

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were. A report on this subject was written by Mr. J. B. Trevor, radio engineer; we assisted him in his tests. His report was essentially a technical one. Suffice it to say that the harmful radiations, if any, that are given off by this apparatus would be soft gamma or Grenz rays. On the strength of that report and one from the Research Division of the Bureau of Medicine and Surgery, various recommendations were made by the Bureau of Medicine and Surgery to the Bureau of Ships and a directive was issued by the Surgeon General. Mr. Trevor's report was recently confirmed by a National Defense Research Committee report on the same subject.

TABLE 2.—Blood pictures of exposed personnel

Case No.	Red blood count	Hema-globin (percent)	White blood count	Differential					
				Band	Seg.	Lymph.	Mono.	Eosine.	Baso.
1.....	5,030,000	96	10,000	2	71	27	0	0	0
2.....	4,870,000	100	13,200	0	65	28	5	2	0
3.....	4,690,000	107	5,500	1	58	29	5	6	1
4.....	4,540,000	100	10,800	0	64	29	6	1	0
5.....	3,990,000	88	5,600	0	49	45	2	1	0
6.....	4,320,000	95	9,200	1	57	38	2	1	1
7.....	4,200,000	100	7,400	1	71	23	3	2	0
8.....	4,870,000	107	9,900	1	70	25	4	0	0
9.....	4,350,000	96	7,100	0	65	23	5	3	4
10.....	4,110,000	90	10,200	2	75	20	2	1	0
11.....	4,950,000	100	9,000	1	57	40	1	0	1
12.....	4,710,000	93	12,200	1	63	33	2	1	0
13.....	4,250,000	92	4,500	2	58	19	11	1	3
14.....	4,210,000	100	7,800	0	53	39	6	2	0
15.....	4,200,000	100	4,300	0	69	27	1	3	0
16.....	5,110,000	100	7,200	1	63	34	2	0	0
17.....	4,820,000	100	9,000	1	66	29	1	3	0
18.....	4,320,000	95	7,800	0	43	42	7	5	3
19.....	4,210,000	100	8,400	0	74	24	2	0	0
20.....	3,710,000	90	9,300	0	62	37	0	1	0
21.....	4,630,000	96	8,100	0	54	42	3	0	1
22.....	4,230,000	100	6,900	0	58	41	1	0	0
23.....	4,850,000	107	7,900	1	73	22	1	3	0
24.....	4,660,000	96	9,200	1	67	23	3	3	0
25.....	4,920,000	100	5,900	1	69	29	1	0	0
26.....	4,620,000	96	6,800	0	51	44	4	1	0
27.....	4,470,000	95	8,400	1	66	27	4	2	0
28.....	4,450,000	100	7,900	0	56	30	7	7	0
29.....	4,480,000	93	10,700	1	61	32	4	2	0
30.....	4,730,000	96	5,200	0	74	25	1	0	0
31.....	4,370,000	93	3,600	0	38	62	8	2	0
32.....	4,550,000	100	7,400	2	44	43	6	3	2
33.....	4,440,000	100	6,200	1	55	42	1	1	0
34.....	4,220,000	96	6,000	1	65	31	2	1	0
35.....	4,440,000	100	7,400	0	67	27	5	1	0
36.....	5,050,000	95	8,000	1	51	43	1	3	1
37.....	4,230,000	95	9,700	1	52	42	4	1	0
38.....	4,900,000	95	4,900	2	65	29	2	2	0
39.....	4,460,000	92	5,700	0	59	34	2	5	0
40.....	5,220,000	100	7,100	2	35	34	3	0	0
41.....	4,130,000	103	8,000	0	59	34	7	0	0
42.....	4,780,000	107	6,700	1	67	29	2	1	0
43.....	4,310,000	95	7,300	0	58	38	2	2	0
44.....	5,360,000	105	8,000	1	65	30	4	0	0
45.....	4,950,000	92	9,700	1	73	17	8	1	0

It is to be noted that there are 6 cases in which the WBC is 10,000 or over. These cases were suffering from upper respiratory infections at the time the count was taken. This percentage of respiratory infections is much less than the average found at this time of the year in the Washington area.

It is also to be noted that there are 2 cases of mild secondary anemia. These are not thought to be significant in a group of 45 persons whose work is almost completely indoors, with practically no exercise and with many more hours of work per day than the average individual. Corrective measures in these cases have always brought the red count up to normal within a short period of time.

*O & P examination of this man's stools revealed an ascaris lumbricoides infection.

Periodic blood counts and physical examinations have been performed during the last 12 months on the research personnel. In tables 2 and 3 results of the last examinations are noted. In respect to possible harmful actions of the radiations on the reproductive systems of the personnel involved, the following resume is enlightening: Out of 45 men, 20 are married and 10 have children or their wives are pregnant. In table 4 the individual's length of exposure to radar and the time their children were conceived in respect to their exposure to radar is noted. There are 10 cases of marriage in which there are no children, but in these cases there has always been a logical explanation concerning the wife's physical condition or contraception has been practiced.

TABLE 3.—Physical examinations of exposed personnel

Case No.	Abnormalities	Total alopecia	Serious illness	Symptoms due to radio frequency		
				Head-aches	Flushed feeling	Incr. beat of face or extremities
1	None	None	None	No	No	No
2	do	do	do	Yes	No	No
3	do	do	do	Yes	No	No
4	do	do	do	No	No	No
5	do	do	do	No	Yes	No
6	do	do	do	No	No	No
7	Sinusitis, chronic	do	do	No	No	No
8	None	do	do	No	No	Yes
9	do	do	do	No	No	No
10	do	do	do	No	No	No
11	do	do	do	No	No	No
12	do	do	do	No	No	No
13	do	do	do	No	No	No
14	do	do	do	No	No	No
15	do	do	do	No	No	No
16	do	do	do	No	No	No
17	do	do	do	No	No	No
18	do	do	do	No	No	No
19	do	do	do	No	No	No
20	do	do	do	Yes	No	No
21	do	do	do	Yes	No	No
22	do	do	do	No	No	No
23	do	do	do	No	No	No
24	do	do	do	No	No	No
25	do	do	do	No	No	No
26	do	do	do	No	No	No
27	do	do	do	No	No	No
28	do	do	do	No	No	No
29	do	do	do	Yes	Yes	No
30	do	do	do	No	No	No
31	do	do	do	No	No	No
32	do	do	do	No	No	No
33	do	do	do	No	No	Yes
34	Accessory mammary gland	do	do	Yes	No	No
35	None	do	do	Yes	No	Yes
36	do	do	do	No	No	No
37	do	do	do	No	No	No
38	do	do	do	Yes	No	No
39	do	do	do	Yes	No	No
40	do	do	do	No	No	No
41	do	do	do	No	No	No
42	do	do	do	No	No	No
43	do	do	do	Yes	No	No
44	do	do	do	No	No	No
45	do	do	do	No	No	No

In the course of this experiment another interesting fact was observed. The radar sets and antennae have a definite field of radio

frequency surrounding them when in operation, and when certain personnel work within these fields, various subjective symptoms are noticed by them:

1. A typical frontal headache located just over the bregma, and occasional intra-ocular pain. This is never very severe and usually occurs after some hours of exposure and disappears spontaneously one-half hour to an hour after exposure ceases. No medication has ever been necessary, and the headaches have never interfered with sleep.
2. The other symptom, which is not quite so common, is a flushed feeling of the face and a heating of the tissues of the hands when these are placed directly in the field.

TABLE 4.—Marital status of exposed personnel

Case No.	Married	Length of marriage	Number of children before exposure to radar	Pregnancies conceived during or after prolonged exposure to radar	Gynecological conditions affecting fertility
1	Yes	3 years	0	0	Uterine displacement.
2	Yes	22 years	3	0	
3	No			0	
4	No				
5	No				
6	No				
7	Yes	5 years	1	0	
8	Yes	10 years	2	0	
9	Yes	1½ years	0	0	
10	No				
11	Yes	1 year	0	0	
12	Yes	2 years	0	0	
13	No			1	
14	No				
15	No				
16	No				
17	No				
18	No				
19	Yes	2 years	0	0	
20	Yes	½ year	0	1	
21	No				
22	Yes	1½ years	0	0	
23	No				
24	No				
25	No				
26	No				
27	Yes	3 years	0	1	
28	No				
29	No				
30	No				
31	No				
32	Yes	16 years	2	0	
33	Yes	18 years	0	0	
34	No				
35	Yes	¼ year	0	0	
36	Yes	½ year	0	1	
37	Yes	1½ years	0	0	
38	Yes	3 years	1	1	
39	No	2½ years	0	0	
40	Yes	¼ year	0	0	
41	No				
42	No				
43	No				
44	No				
45	Yes	15 years	0	3 (1)	

(1) Hysterectomy performed during third pregnancy for uterine tumor.

This area of radio frequency is quite limited in its effect, i. e., it is apparently only noticed within 3 or 4 feet of a transmitter or antenna

that is working very efficiently at a peak load. The symptoms attributable to this were always mild. When compared with the standard diathermy outfits used in medical practice today, the output is quite low and inefficient.

Another question that has been raised by various reports from fleet activities is the possibility of alopecia due to the radiations. In all 45 subjects there is not one case of complete baldness and not more than the normal percentage of temporal and occipital thinning out of the hair due to age. In 2 cases there is a premature thinning of the hair which the individuals say has been progressive for years and is a familial characteristic. With these exceptions the average head of hair may be described as good.

SUMMARY

1. A group of 45 men with exposure to radar and high-frequency radio, varying from 2 months to 9 years, have been observed for the past 12 months.
2. Periodic physical and blood examinations of these individuals have been within the normal range.
3. The reproductive tissues do not seem to have suffered clinically any demonstrable damage, as judged by the number of conceptions and normal pregnancies during the time of exposure of the fathers to radar.
4. We have been unable to find any abnormal or premature alopecias that could be connected with exposure to radar.
5. There have been no unusual dermatological manifestations.

CONCLUSIONS

1. During the preliminary and present work on radar and high-frequency radio by personnel who are constantly exposed to the equipment and its emanations, both in a shielded and an unshielded condition, there has been no clinical evidence of damage to these personnel.
2. It is thought advisable that directives as to shielding of equipment and periodic medical checkup of personnel be continued to prevent a rather remote possibility of an occasional injury due to overexposure of personnel.
3. It is to be noted that the radio-frequency energy of radar is not different from that of other high-frequency radio or diathermy units of an equivalent average power.

The clinical laboratory work in this investigation was done by James Stewart Otto, pharmacist's mate, first class, U. S. N., and James John Lawson, Jr., pharmacist's mate, first class, U. S. N. R., who are both qualified laboratory technicians.