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MAIN SUBJECT HEADING:

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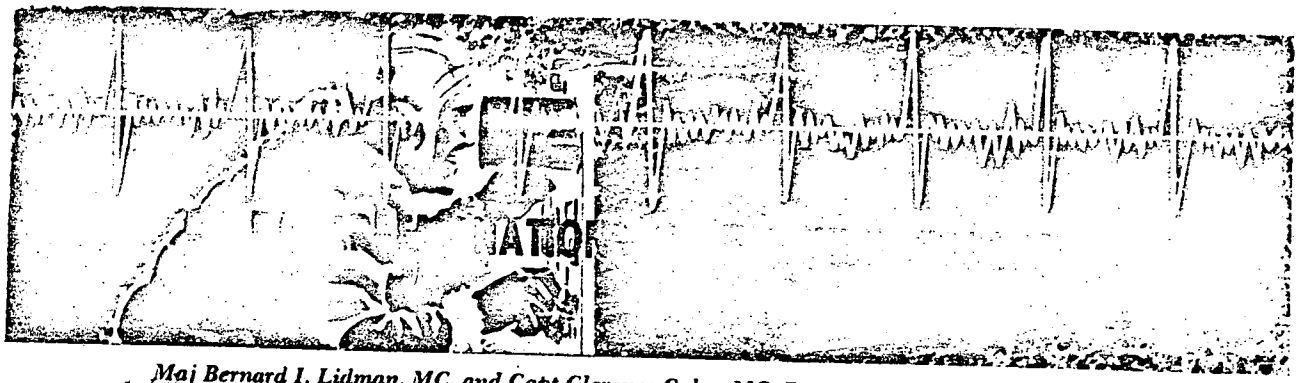
ANALYTICS	HUMAN EFFECTS	ANIMAL TOXICITY	WORKPLACE PRACTICES-ENGINEERING CONTROLS	MISCELLANEOUS

SECONDARY SUBJECT HEADINGS: AN HU AT IH M

- Physical/Chemical Properties
- Review
- Animal Toxicology
- Non-occupational Human Exposure
- Occupational Exposure
- Epidemiology
- Standards
- Manufacturing
- Uses
- Reactions
- Sampling/Analytical Methods
- Reported Ambient Levels
- Measured Methods
- Work Practices
- Engineering Controls
- Biological Monitoring
- Methods of Analysis
- Treatment
- Transportation/Handling/Storage/Labelling



Maj Bernard I. Lidman, MC, and Capt Clarence Cohn, MC, Boca Raton Army Air Field, Florida

"Effects of Radar Emanations on the Hematopoietic syst

THE Naval Research Laboratory has reported on 45 individuals exposed to radar emanations for as long as 9 years. Hematologic studies, including red blood cell counts, hemoglobin determinations, white blood cell counts, and differential smears, were within normal range. The Aero Medical Laboratory, Air Technical Service Command, has reported on the absence of untoward reactions in male guinea pigs exposed to heavy discharge of radar emanations. No effect was apparent on the behavior, reproductive activity, growth, and appearance of the guinea pigs. Histologic examination of the tissues of the experimental animals, including bone marrow, revealed no changes. In addition, active spermatogenesis was found in the testes of all the animals.

Studies by Division 14, National Defense Research Council, indicated that "the power which can be dissipated in a subject exposed to microwaves from the radar systems of highest power under the worst possible conditions (paraboloid stationary with subject directly in front of it and absorbing all the incident energy) is of the same order of magnitude as that used in high frequency therapy." With rotating paraboloids, it was shown that the power dissipated was only 0.05—10 per cent of that ordinarily absorbed in therapeutic high frequency radiation, or short-wave diathermy.

It had previously been determined that stray roentgen radiations may emanate from glass-walled, pulser, oscillator, clipper, or rectifier tubes, although the roentgen radiations from the last 2 are within safe limits (Division 14, National Defense Research Council). The magnetron tubes are of no importance in this respect; although very weak roentgen radiations may appear when the tube is fluorescing, none escape from the envelope or glass filament leads of the tube. Accepting 0.1 roentgen per 8 hour day as an absolutely safe level of exposure, it is apparent that the intensity level of 0.01—0.001 roentgen, measured in the immediate vicinity of shielded sets, affords operators and mechanics a far wider margin of safety than is considered necessary by the most conservative authorities in radiology. Roentgen rays produced within the tubes of radar sets are soft and easily stopped by steel and aluminum shielding cabinets. It is accepted, on the basis of studies by the National Defense Research Council, that the metal hull of an airplane affords ample protection from roentgen radiations to the set operator and crew members. By the same reasoning, a closed, shielded set is not a source of potential danger for the student operator in the laboratory. The personnel who may be exposed to stray roentgen radiations are the mechanics and laboratory maintenance technicians whose duties might necessitate their exposure to operating open sets. This problem can be solved by surrounding the open set with a protective metal shield of approved thickness.

Method

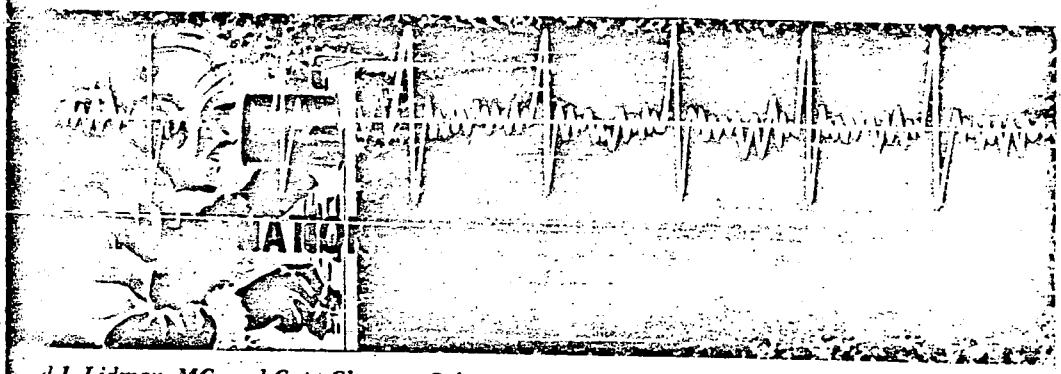
A group of 124 officers and enlisted men volunteered for this study. The subject volunteers were selected from a large group of radar instructors, mechanics, and laboratory maintenance technicians, personnel who had had prolonged exposure to emanations from both shielded and unshielded equipment. Operators of airborne radar equipment were considered the least valuable source of such material. None of the subject volunteers had been exposed to high altitude flying. The volunteers selected were either students, instructors, or technicians in 6 courses of study. Duration of exposure varied from 2 to 36 months. Twenty enlisted men, who had had no exposure to radar emanations, volunteered to serve as controls.

All hematologic and chemical studies were performed by the same laboratory technicians, with duplicate determinations on all specimens. The icteric indexes were done by the acetone precipitation method of Newburger which provides a normal range of 2 to 5 units. In this study only values above 7 units were considered abnormal. All hemoglobin determinations, total proteins, and icteric indexes were done by spectrophotometric methods. Wintrobe hematocrit tubes were employed in estimating the volume of packed erythrocytes. Wintrobe's nomogram was used in calculating the mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration.

Results

Because, throughout this study, the possible effect of radioactive substance (stray roentgen radiations) on the hematopoietic system is to be considered, a brief review of possible effects from such exposure may be presented. It might be mentioned that in cases of *internal irradiation*, with which our study does not concern itself, a severe macrocytic anemia, with leukopenia, may develop. In cases of *external irradiation*, as in exposure to roentgen rays, the primary effect observed is on the leukocytes. A leukopenia may occur. In cases of marked overexposure, there may be an absolute granulocytopenia with an absolute lymphocytosis or monocytosis. An increase in eosinophils has been noted in cases of overexposure to roentgen rays, and abnormal and immature white blood cells have been seen. The response of thrombocytes to irradiation is variable. There may be an early increase in platelets followed by a slight decrease. The erythropoietic system may be markedly affected in instances of excessive exposure to external irradiation.

No such effects of radar emanations were noted in this study. Values obtained in studies performed on radar personnel, including men in 6 courses of study, were



I. Lidman, MC, and Capt Clarence Cohn, MC, Boca Raton Army Air Field, Florida

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No such effects of radar emanations were noted in this study. Values obtained in studies performed on radar personnel, including men in 6 courses of study, were

within the accepted range of normal and did not vary significantly from those obtained in the study of controls (see table). There was no evidence of stimulation or depression of the hematopoietic system.

Determinations of mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration revealed no evidence of macrocytosis or microcytosis. The average erythrocyte count was 4,750,000. This value falls within the same range as that of the controls. Although this value is slightly lower than the generally accepted 5,000,000, it has been the experience at this station, and at others, that the average erythrocyte count in male Army personnel more closely approximates the former value. The highest and lowest values obtained were within normal range. These statements similarly apply to the results obtained in hemoglobin and hematocrit determinations. The reticulocyte counts were within the normally accepted range but were significantly higher in the exposed subjects than in the controls.

From the total white blood cell counts and differential smears obtained, there was no evidence of leukopenia, leukocytosis, granulocytopenia, lymphocytosis, or eosinophilia. The average white blood cell count was approximately 7,000. One high of 16,050 and one low value of 3,600, proved to be normal on re-check.

No increase or decrease in blood platelets was found. Plasma protein determinations revealed normal values in all instances.

In 20 (16 per cent) of the 124 radar personnel, the icteric indexes were elevated above normal values. Follow-up studies on these individuals indicated that the elevated icteric indexes were not indicative of increased blood destruction. In some instances, biliary tra was discovered. In others, hepatitis was responsible fo bilirubinemia. It is the opi writers that some cases of jau panied the outbreak of infec nucleosis observed at this sta the period of the survey. Sim have been reported previousl

Conclusion

No evidence was discov might indicate stimulation o of the erythropoietic and systems of personnel exposed tions from standard radar s longed periods.

The authors wish to express thei to Sergeant Eugene Sawicki, M ment, and Sergeant Genevieve S n's Army Corps, for their techn

TABLE

HEMATOLOGIC STUDIES ON RADAR EXPOSED SUBJECTS AND CONTROLS
MEANS AND STANDARD DEVIATIONS

Groups	Controls	Course A	Course B	Course C	Course D	Course E
Number of Persons	20	10	10	34	10	47
Exposure (months)	0	2	17	16	16	14
RBC (1 x 10^6/cu. mm.)	4.69 ± 0.18	4.88 ± 0.39	4.75 ± 0.33	4.72 ± 0.12	4.72 ± 0.28	4.66 ± 0.21
WBC (/cu. mm.)	7320 ± 1386	7690 ± 3040	6870 ± 1350	7100 ± 1340	6750 ± 1280	6760 ± 1700
Hemoglobin (%)	91.3 ± 4.0	92.1 ± 2.5	97.2 ± 4.6	95.4 ± 2.3	87.0 ± 3.7	93.7 ± 3.5
Hematocrit (%)	41.2 ± 2.6	41.9 ± 1.8	44.4 ± 2.3	39.9 ± 3.5	42.3 ± 2.2	41.2 ± 3.3
Platlets (1 x 10^3/cu. mm.)	2570 ± 530	2410 ± 595	2460 ± 570	2230 ± 570	2080 ± 520	2430 ± 880
Icteric Index	3.7 ± 0.15	5.6 ± 0.42	4.2 ± 1.9	5.2 ± 0.52	4.9 ± 1.95	3.9 ± 2.2
Proteins (gm. %)	7.5 ± 0.40	6.9 ± 0.41	7.1 ± 0.50	6.9 ± 0.12	7.2 ± 0.68	6.8 ± 0.2
Reticulocytes (%)	0.27 ± 0.05	0.63 ± 0.08	0.51 ± 0.02	0.45 ± 0.03	0.9 ± 0.07	0.5 ± 0.03
Mean Corp. Vol. (cu. μ)	92	88	90	83	88	90
Mean Corp. Hb (γγ)	28.0	26.5	30	29	26.5	29
Mean Corp. Hb Conc. (%)	33	33	34.5	35	30.0	34

SUMMARY OF MEDICAL STATISTICS, AAF, CONTINENTAL USA*

September 1945 (Four weeks—31 August to 28 September)

COMMAND	ANNUAL ADMISSION RATE NEW CASES† All Causes	Disease	Injury	Noneffective Rate**	Mean Days Lost Per Admission	ANNUAL ADMISSION RATE FOR CERTAIN DISEASES† Common Respiratory	Pneumonia	Diarrhea & Dysentery
US AAF	420.3	384.7	35.6	24.0	20.8	67.2	6.3	7.0
HQ CAF STA.	452.9	403.2	49.7	22.7	18.2	63.1	7.9	9.4
1st AF	413.2	376.9	36.3	24.2	21.3	60.0	4.9	2.8
2nd AF	383.2	356.3	26.9	14.4	13.7	55.2	3.9	9.9
3rd AF	345.4	318.9	26.5	12.1	12.8	62.2	2.7	7.8
4th AF	461.5	414.3	47.2	19.9	15.7	72.4	2.7	3.4
TCC	438.6	404.9	33.7	11.0	9.2	45.9	3.3	10.2
ATSC	460.8	427.5	33.3	16.9	13.3	96.5	2.6	6.8
ATC	432.3	394.2	38.1	10.3	8.6	72.4	2.2	7.6
TTC	388.8	359.9	28.9	21.2	19.8	80.9	16.4	6.7
FTC	379.8	340.0	39.8	11.0	10.5	58.6	6.7	7.3

*Obtained from Statistical Health Reports WDAGO 8-122.
†Rate calculated on annual basis, per 1000 mean strength per year.
**Average number of personnel per 1,000 absent from duty for medical reasons.

SUMMARY OF VENEREAL DISEASE RATES, AAF, CONTINEN

September 1945 (Four weeks—31 August to 28 September)

ADMISSION RATES FOR NEW CASES, PER 1,000 MEAN STRENGTH P

COMMAND	WHITE AND COLORED All Types	Gonorrhea	Syphilis	Other V D	WHITE All Types	Gonorrhea	Syphilis	Other V D	CO All Types	Gonorrhea
USAAF	48.1	43.0	4.4	0.7	33.7	30.5	3.0	0.2	289.8	254
HQ CAF STA	45.0	39.9	4.1	1.0	32.2	28.9	3.3	—	286.0	244
1st AF	56.0	50.9	4.5	0.6	26.6	24.7	1.9	—	326.0	291
2nd AF	41.1	37.5	3.3	0.3	34.0	31.1	2.8	0.1	209.1	190
3rd AF	59.9	52.6	6.4	0.9	31.9	28.5	3.1	0.3	386.6	338
4th AF	39.3	35.5	3.2	0.6	28.7	26.8	1.9	—	265.1	218
TCC	79.9	72.3	4.3	3.3	59.9	56.6	2.9	0.4	280.0	229
ATSC	80.1	74.0	5.4	0.7	38.5	36.9	1.6	—	360.7	342
ATC	49.7	44.6	4.4	0.7	45.0	40.2	4.2	0.6	238.1	221
TTC	28.5	25.5	2.9	0.1	24.4	22.1	2.2	0.1	129.6	116
FTC	41.7	37.3	3.9	0.5	29.9	27.0	2.6	0.3	239.3	202

*Obtained from Statistical Health Reports WDAGO 8-122.
†EPTS cases (existed prior to service) excluded.
STATISTICS BRANCH—Office of the Air Surgeon.

within the accepted range of normal and did not vary significantly from those obtained in the study of controls (see table). There was no evidence of stimulation or depression of the hematopoietic system.

Determinations of mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration revealed no evidence of macrocytosis or microcytosis. The average erythrocyte count was 4,750,000. This value falls within the same range as that of the controls. Although this value is slightly lower than the generally accepted 5,000,000, it has been the experience at this station, and at others, that the average erythrocyte count in male Army personnel more closely approximates the former value. The highest and lowest values obtained were within normal range. These statements similarly apply to the results obtained in hemoglobin and hematocrit determinations. The reticulocyte counts were within the normally accepted range but were significantly higher in the exposed subjects than in the controls.

From the total white blood cell counts and differential smears obtained, there was no evidence of leukopenia, leukocytosis, granulocytopenia, lymphocytosis, or eosinophilia. The average white blood cell count was approximately 7,000. One high of 16,050 and one low value of 3,600, proved to be normal on re-check.

No increase or decrease in blood platelets was found. Plasma protein determinations revealed normal values in all instances.

In 20 (16 per cent) of the 124 radar personnel, the icteric indexes were elevated above normal values. Follow-up studies on these individuals indicated that the elevated icteric indexes were not indicative of increased blood destruction. In some instances, biliary tract pathology was discovered. In others, infectious hepatitis was responsible for the hyperbilirubinemia. It is the opinion of the writers that some cases of jaundice accompanied the outbreak of infectious mononucleosis observed at this station during the period of the survey. Similar findings have been reported previously.

Conclusion

No evidence was discovered which might indicate stimulation or depression of the erythropoietic and leukopoietic systems of personnel exposed to emanations from standard radar sets over prolonged periods.

The authors wish to express their appreciation to Sergeant Eugene Sawicki, Medical Detachment, and Sergeant Genevieve Sullivan, Women's Army Corps, for their technical assistance.

TABLE

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MEANS AND STANDARD DEVIATIONS

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WBC (/cu. mm.)	7320 ±1386	7590 ±3040	6870 ±1350	7100 ±1340	6750 ±1280	6760 ±1700	8060 ±1250
Hemoglobin (%)	91.3 ±4.0	92.1 ±2.5	97.2 ±4.6	95.4 ±2.3	87.0 ±3.7	93.7 ±3.5	95.5 ±1.8
Hematocrit (%)	41.2 ±2.6	41.9 ±1.8	44.4 ±2.3	39.9 ±3.5	42.3 ±2.2	41.2 ±3.3	40.1 ±1.1
Platlets (1 x 10^3/cu. mm.)	2570 ±530	2410 ±595	2460 ±670	2230 ±570	2080 ±520	2430 ±880	2520 ±423
Icteric Index	3.7 ±0.15	5.6 ±0.42	4.2 ±1.9	5.2 ±0.82	4.9 ±1.95	3.9 ±2.2	4.4 ±1.8
Proteins (gm. %)	7.5 ±0.40	6.9 ±0.41	7.1 ±0.55	6.9 ±0.12	7.2 ±0.68	6.8 ±0.2	7.0 ±0.26
Reticulocytes (%)	0.27 ±0.05	0.63 ±0.08	0.51 ±0.02	0.45 ±0.03	0.9 ±0.07	0.5 ±0.03	0.45 ±0.02
Mean Corp. Vol. (cu. μ)	92	88	90	83	88	90	86
Mean Corp. Hb (γγ)	28.0	26.5	30	29	26.5	29	30
Mean Corp. Hb Conc. (%)	33	33	34.5	35	30.0	34	34

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September 1945 (Four weeks—31 August to 28 September)

COMMAND	ANNUAL ADMISSION RATE NEW CASES†			Noneffective Rate**	Mean Days Lost Per Admission	ANNUAL ADMISSION RATE FOR CERTAIN DISEASES†		
	All Causes	Disease	Injury			Common Respiratory	Pneumonia	Diarrhea & Dysentery
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1st AF	413.2	376.9	36.3	24.2	21.3	60.0	4.9	2.8
2nd AF	383.2	356.3	26.9	14.4	13.7	55.2	3.9	9.9
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SUMMARY OF VENEREAL DISEASE RATES, AAF, CONTINENTAL USA*

September 1945 (Four weeks—31 August to 28 September)

ADMISSION RATES FOR NEW CASES, PER 1,000 MEAN STRENGTH PER YEAR†

COMMAND	WHITE AND COLORED				WHITE				COLORED			
	All Types	Gonorrhea	Syphilis	Other V D	All Types	Gonorrhea	Syphilis	Other V D	All Types	Gonorrhea	Syphilis	Other V D
USAAF	48.1	43.0	4.4	0.7	33.7	30.5	3.0	0.2	289.8	254.1	28.3	7.4
HQ CAF STA	45.0	39.9	4.1	1.0	32.2	28.9	3.3	—	286.0	245.2	20.4	20.4
1st AF	56.0	50.9	4.5	0.6	26.6	24.7	1.9	—	326.0	291.3	28.9	5.8
2nd AF	41.1	37.5	3.3	0.3	34.0	31.1	2.8	0.1	209.1	190.7	13.8	4.6
3rd AF	59.9	52.6	6.4	0.9	31.9	28.5	3.1	0.3	386.6	334.6	43.9	8.1
4th AF	39.3	35.5	3.2	0.6	28.7	26.8	1.9	—	265.1	218.5	32.1	14.3
TCC	79.9	72.3	4.3	3.3	59.9	56.6	2.9	0.4	280.0	229.1	18.2	32.7
ATSC	80.1	74.0	5.4	0.7	38.5	36.9	1.6	—	380.7	342.4	32.3	6.0
ATC	49.7	44.6	4.4	0.7	45.0	40.2	4.2	0.6	238.1	221.5	11.1	5.5
TTC	28.5	25.5	2.9	0.1	24.4	22.1	2.2	0.1	129.6	110.6	19.0	—
FTC	41.7	37.3	3.9	0.5	29.9	27.0	2.6	0.3	239.3	207.8	27.0	4.5

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