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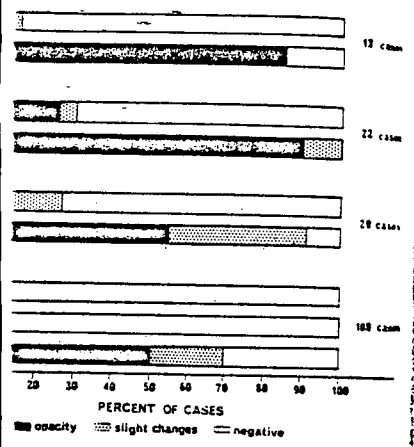
- Occupational Exposure
- Epidemiology
- Standards
- Manufacturing
- Uses
- Reactions
- Sampling/Analytical Methods
- Reported Ambient Levels
- Measured Methods
- Work Practices
- Engineering Controls
- Biological Monitoring
- Methods of Analysis
- Treatment
- Transportation/Handling/Storage/Labelling



ponse of lens to microwave irradiatio
five weeks to over one year in age.

st on the second day following a
ure to radiation. Slight changes de-
he third or fourth day. Circum-
ffuse opacities were evident in the
tex on the fourth day and reached
l development within one or two

Conclusions

eriments fail to demonstrate any
lationship between the age of the
e susceptibility of its lens to dam-
wave radiation. Likewise, neither
eriod before appearance of an
ie type of cataracts can be related
the animal.

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MR 182

Cataract Incidence in Radar Workers

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Introduction

EXPOSURE to microwave radiation has duced cataracts in experimental animals[1] has also been implicated in the induction cataracts in man following accidental over-posure to microwaves emanating from radar uipment.[2-4] These exposures were principally cute in nature, and at levels significantly ater than normally encountered in the oc-pational exposure of microwave workers. e disturbing possibility that chronic low-el microwave exposure could result in an in-ase in the risk of cataract formation among rowave workers has been suggested by ani-l experiments in which cataracts were pro-ced by repeated subthreshold irradiation.[5] contingency had not been previously ex-ned owing to the difficulties involved in ob-ning a representative study group of quate size. The method employed in this ly utilized information that was readily ilable in military service records to estimate relative risk of cataract formation associated itary occupational microwave employ-

Methods

ning the study a choice had to be made retrospective or a prospective method of The prospective approach would involve the n of the occupationally exposed group and le control group, and a follow-up of their cataract experience for comparison. The e approach would entail the identification of men with cataracts and a group not so afflicted, followed by a comparison of occupational exposure to microwaves as determined by their military records. Had it been feasible, the prospective approach would have been chosen since it would have avoided certain ambiguities in the interpretation of the data. However, cataracts diagnosed in the medical care system of the Veterans Administration were estimated to have a total incidence of only about 0.2% for World War II military personnel by 1962, whereas the incidence of occupational exposure to microwave radiation was thought to have been greater, perhaps 0.5%. The greater expected yield of the retrospective method, and the advantage is afforded as a non-subjective means of differentiating microwave workers from controls, dictated its selection for this study.

It was realized that in a retrospective study it is sometimes difficult to arrive at unequivocal conclusions as to the relationship between the study factor and the disease of interest. (For example, a given factor may seem to be associated with a disease only because it influences the probability of ascertainment). In the setting of the military-veteran population, however, where the original occupational experience is documented without being influenced by later events, the opportunities for bias are fewer than those usually encountered. Even in the present investigation, which relied on the hospital records of the Veterans Administration for the ascertainment of cataracts, bias would nevertheless arise if former radar workers differed from other occupational groups in their use of Veterans Administration hospitals for diagnosis and treatment. Such bias could be present whether the prospective or retrospective approach were chosen, and additional evidence would be required before an association could be confirmed. Such evidence would consist of a definite relationship between the incidence of cataracts and the degree of microwave exposure among the microwave workers alone.

The population sampled consists of Army and Air Force veterans of World War II and the Korean War. It includes radar workers assumed to have been occupationally exposed to microwave radiation during their military service. Other essential characteristics of the population are the availability and suitability of hospital and military occupational records for objective sampling and classification.

A preliminary analysis was performed to determine the required sample size as a function of the magnitude of the effect to be detected and the expected proportion of radar workers in the sample. It was

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TABLE 1.—*Classification of World War II and Korean War Veterans With and Without Cataracts According to Branch of Service and Military Occupation, Based on Discharges From VA Hospitals, 1950-1962*

Branch of Service	Veterans With Cataracts	Veterans Without Cataracts
US Army	2,048	1,010
mean age (yr)	44.3	42.9
US Air Force	98	120
mean age (yr)	37.4	35.5
Personnel with no indicated occupational specialties (both branches of service)	202	125
Total sample	2,946	2,164
mean age (yr)	44.06	41.92
Military occupation		
Radar workers	19	21
Nonradar workers	2,625	1,935
Unclassified personnel (ie, occupational specialties not determinable from indicated MOS's)	100	83

$$R = \frac{(19)\ (1,935)}{(21)\ (2,625)} = 0.67$$

determined that a sample of approximately 2,500 cataract cases and a control group of the same size would be sufficient to permit the detection of a twofold increase in the relative risk, with a probability of 0.80, at an 0.05 level of significance. This order of effect to be detected (ie, 2:1) was considered to provide adequate sensitivity for a study of this type since it would be difficult to attribute much practical significance to effects of lower order.

The military records of each veteran were abstracted to determine military occupational specialties (MOS's), which were subsequently used to categorize the members of the cataract and the control group as either radar or nonradar workers. The association between cataract induction and military radar employment was then analyzed by applying appropriate statistical methods to the retrospective data.

Since 73 diagnostic rubrics for cataracts are specified in the *AMA Standard Nomenclature of Diseases and Operations*,[5] it was necessary to eliminate from the sampling plan those which could not conceivably be related to microwave exposure: congenital cataracts, cataracts in mongolism, congenital cataracts due to inflammation, traumatic cataract due to contusion or due to penetrating wounds, and diabetic cataract. Consideration was also given to the exclusion of cataracts attributed to etiologies other than microwave exposure. This latter restriction was not adopted, however, since it could not be assumed that etiologic inferences in the clinical records were correct. Only relatively recently has microwave radiation been regarded a cataractogenic, and it seemed possible that occupational exposure to microwave radiation might hasten the maturation of cataracts originating independently of such exposure. In any event, the main reason for a controlled epidemiological study was to obtain observations that would be essentially independent of clinical opinion as to etiology. If the investigation produced evidence of microwave induced cataracts, it was expected that further diagnostic study would be possible on the individuals identified in the study.

The sampling plan included a lower limit of 1911 on the year of birth, to minimize dilution of the sample with senile cataracts. In the event that occupational microwave exposure shortened the latent period for senile cataract formation among microwave workers, this age limitation would serve to emphasize cataractogenic effects independent of age that might otherwise be obscured if the overall proportion of senile cataracts in the sample was large.

A limitation was also placed on the branches of military service from which the sample was selected. Navy veterans were excluded from the sample because it was advised that shipboard exposure to microwave radiation might not be well indexed by MOS and that MOS's were not available from Navy records. The sample was thus confined to Army and Air Force veterans.

The diagnostic indices of all hospitals in the Veterans Administration system were screened to select a sample of 2,946 white male Army and Air Force veterans born after 1910 who had been treated for cataracts in the interval 1950-1962, inclusive. A control sample of 2,164 Army and Air Force veterans was obtained from the same sources by selecting men with adjacent hospital register numbers. The control group was thus composed of men with random diagnoses, made in the same hospitals and at the same time as the cataract diagnoses, and limited to Army and Air Force veterans born after 1910. The disparity between the sizes of the cataract and control groups was due to the ineligibility of potential controls because of age or branch of service.

Results

The classification of cataract cases and controls according to radar work status is shown in Table 1. The observed or estimated relative risk of cataract formation may be expressed as:[6]

$$R = \frac{AD}{BC}$$

A indicates the number of radar workers with cataracts.

B indicates the number of nonradar workers with cataracts.

C indicates the number of radar workers without cataracts.

D indicates the number of nonradar workers without cataracts.

The expected value of R on the assumption of no increase in the relative risk is one, and the degree by which the observed R exceeds this value is an indication of the severity of the effect

TABLE 2.—*Relativ*

Branch of Service and Diagnosis	No. Radar Work
Army	
Cataract	15
Other	18
Air Force	
Cataract	4
Other	3
Summary estimate of relativ	

being considered. The statisti
of R may be determined by for
tistic that, under the assumptio
relative risk is unity, a χ^2 distribu
with one degree of freedom.[6]

The relative risk of cataract
estimated from the retrospecti
0.67 and the corresponding χ^2
does not indicate a significant
from unity. It is of interest to
though the estimate of the over
was nonsignificant statistically, i
one, indicating that veterans wit
exposure to microwave radiati
with cataracts in VA hospitals
other military occupational grou

In addition to estimating the
risk, it was necessary to consid
risk in selected segments of the s
of the possibility that the ri
homogeneous. The cataract and
ples were therefore partitioned
branch of military service and

TABLE 3.—*Rel*

Age and Diagnosis	No. Radar Workers
50-54	
Cataract	9
Other	4
40-49	
Cataract	7
Other	13
20-39	
Cataract	3
Other	4
Summary estimate of relat	

TABLE 2.—*Relative Risk of Cataracts Among Veterans by Branch of Service*

Branch of Service and Diagnosis	No. Radar Workers	No. Nonradar Workers	Estimated Relative Risk	χ^2 value	Significance Level, *P*
Army					
Cataract	15	2,589			
			0.60	1.74	>0.10
Other	18	1,876			
Air Force					
Cataract	4	36			
			2.18	0.38	>0.10
Other	3	59			
Summary estimate of relative risk[a]			0.75	0.25	>0.10

being considered. The statistical significance of R may be determined by forming a test statistic that, under the assumption that the true relative risk is unity, a χ^2 distribution will follow with one degree of freedom.[6]

The relative risk of cataract formation was estimated from the retrospective data to be 0.67 and the corresponding χ^2 value of 1.26 does not indicate a significant departure of R from unity. It is of interest to note that, although the estimate of the overall relative risk was nonsignificant statistically, it was less than one, indicating that veterans with occupational exposure to microwave radiation were seen with cataracts in VA hospitals less often than other military occupational groups.

In addition to estimating the overall relative risk, it was necessary to consider the relative risk in selected segments of the sample, in view of the possibility that the risk might be homogeneous. The cataract and control samples were therefore partitioned according to branch of military service and age to permit the relative risk to be examined in relation to these factors. The two military branches differed in both usage and type of radar equipment. Such variation could conceivably result in differences in the average amount of microwave exposure to members of these branches, thereby altering their cataract incidence.

The results of the analysis within branch of service are presented in Table 2. Although the relative risk exceeds 2 for Air Force veterans, it is based on too few observations to be of any consequence.

Relative risks were also adjusted for age because it is well known that the incidence of cataracts increases with age. If radar workers with cataracts were appreciably younger than hospitalized veterans generally, their apparent equivalence in unadjusted relative risk might conceal an increased risk at the younger ages for radar workers. The analysis by age, shown in Table 3, suggests no alteration in the age-specific incidence of cataracts as a result of exposure to microwave radiation.

TABLE 3.—*Relative Risk of Cataracts Among Veterans by Age*

Age and Diagnosis	No. Radar Workers	No. Nonradar Workers	Estimated Relative Risk	χ^2 value	Significance Level *P*
50-64					
Cataract	9	699			
			1.02	0.08	>0.10
Other	4	316			
40-49					
Cataract	7	1,517			
			0.39	3.39	>0.05
Other	13	1,101			
20-39					
Cataract	3	418			
			0.94	0.09	>0.10
Other	4	522			
Summary estimate of relative risk			0.61	1.82	>0.10

Discussion

The results suggest that occupational exposure to microwave radiation of the power generated by Army and Air Force equipment in World War II and the Korean War did not change the risk of cataract formation in men using such equipment. Although the study has good statistical power against the possibility that such exposure may have more than doubled the usual risk of cataract formation, the negative case is never proved statistically and smaller effects remain a possibility. Smaller effects, however, would probably be of uncertain importance. In view of the evidence that microwave radiation is cataractogenic,[2] these results indicate that military occupational exposure, as limited by such safety measures as have been possible in wartime, was nevertheless at a relatively safe level in World War II and the Korean War.

Inasmuch as the study rests on the incomplete ascertainment possible with VA hospital indices, the results are open to the objection that former radar workers may not have utilized VA hospitals in the same way as veterans with other military occupations. Such utilization rates were not sought in this study because: (1) a generally lower (or higher) rate of use would not bias the results of the study provided the difference in use applied equally to cataracts and other diagnoses; and (2) the publicized effects of radar might actually tend to encourage a somewhat higher frequency of resort to VA hospitals on the part of former radar men with cataracts, in comparison with other occupational groups. For these reasons it was believed that a negative result would constitute good evidence against the importance of ordinary occupational exposure in producing cataracts, but that a positive result would have to be investigated further.

It should be pointed out that the equipment used in World War II and in the Korean War was less powerful than that currently employed, and that the present occupational hazard may not be fairly represented by the earlier experience. As more information is obtained regarding the degree and type of microwave exposure received by individuals under different circumstances, and as the biological effects become better understood and recognized, more definite conclusions should be forthcoming.

Conclusion

Occupational exposure to microwave radiation on the part of Army and Air Force personnel during World War II and the Korean War probably did not increase their risk of developing cataracts before 1963. The results of an analysis of cataract incidence among personnel of the US Army and US Air Force do not provide evidence to support the hypothesis of an increase in the relative risk of cataract induction as a result of military occupational microwave employment. Adjustment of the relative risk for branch of military service and age had no significant effect on the results of the analysis.

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Pat

I. Evaluations of Subsystem

CAPT SMITH SHA
MAJ MARIA LACONI

APPLICATION of germfr
patient care has led to the
flexible plastic isolators for
sterile operative fields[1,2] as
more elaborate systems for cor
longed patient isolation.[3,4] The
contained units, are designe
complete isolation of the patie
quiring either architectural mod
ward upon which they are instal
barriers to medical and nursin
cedures. One such isolator, th
Hospital Isolation System" Ma
has been subjected to a series
and clinical evaluations. This r
the preclinical studies and inclu
of, first, the various subsystem
maintenance of the microbial ir
unit; and, second, various germ
tizing agents for use in concu
and sanitization procedures of th
during actual occupancy.

A. *Determination of the Reli
Air Filtration System.*—The air
of the isolator employs two ultra
filter (UHEF) units,† one for
source of filtered air to the iso
second for filtering exhaust air
charge when required. Specificat
units[5] require an efficiency
99.99% in removal of particles
5μ size range. In addition, a
roughing filter is provided as

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search, Walter Reed Army Medical Center.
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Richmond, Va (Dr. S. Shadomy).
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