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EVALUATION OF ULTRAVIOLET RADIATION AND DUST CONTROL MEASURES IN CONTROL OF RESPIRATORY DISEASE AT A NAVAL TRAINING CENTER*

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The effectiveness of dust suppression by means of oiling floors and blankets for the control of air-borne respiratory disease is not fully determined.[5] The Commission on Acute Respiratory Diseases and the Commission on Air-borne Infections, in a study at Fort Bragg, North Carolina, found that these measures had only a slight questionable effect in reducing respiratory disease in barracks under endemic conditions and were ineffectual in controlling an epidemic in recruits.[1] Methods of dust suppression, and encouraging bacteriological results obtained by the Board for the Investigation of Epidemic Diseases, United States Army, have been described by Robertson, et al.[2] Effectiveness in practice was under determination at that time but has not yet been published.

Studies of the effectiveness of ultraviolet irradiation in reducing the rates of respiratory disease in military barracks were conducted at Sampson Naval Training Center from 1943 to 1945. The results of the first season's study indicated a reduction 25% in the radiated group.[3] A preliminary analysis of the second year's work gave a reduction in the radiated group of about 18%. Due to exigencies of wartime, loss of continuity of personnel, mass chemoprophylaxis against a scarlet fever outbreak and administrative difficulties, further statistical analysis of the second year data appeared inadvisable.[4] During the winter of 1945–46, these studies were transferred to the Great Lakes Naval Training Center where further observations were made. The results during this year are the subject of the present paper.

Semi-isolated military organizations

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* The views and opinions expressed in this article are those of the authors and do not necessarily reflect those of the Navy Department.

1. Commission on Acute Respiratory Diseases and Commission on Air-Borne Infections, A Study of the Effect of Oiled Floors and Bedding on the Incidence of Respiratory Disease in New Recruits. 1946, Am. J. Pub. H. **43**: 120–144.
2. Robertson, O. H., Hamburger, M., Loosli, C. S., Puck, T. T., Lemon, H. M., and Wise, J. 1944, Nature and Control of Air-borne Infection in Army Camps. J.A.M.A. **126**: 993.
3. Wheeler, S. M., Ingraham, H. S., Hollaender, A., Lill, N. D., Gershon-Cohen, J., and Brown, E. W. 1945. Ultraviolet Light Control of Air-Borne Infections in a Naval Training Center, Am. J. Pub. H. **35**: 457–468.
4. Willmon, T. L., and Hollaender, A. Three Years' Experience in Use of Ultraviolet Radiation and Dust Suppressive Measures in Reduction of Upper Respiratory Infection in Naval Barracks, Am. J. Pub. H. (to be published).
5. Thomas, John C., and van den Ende, M. 1941, The Reduction of Dust Borne Bacteria in the Air of Hospital Wards Liquid Paraffin Treatment of Bedclothes, Brit. Med. J. **1**: 953.

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offer many advantages over civilian groups for epidemiological studies. Recruit training camps offer special advantages since they are composed of unseasoned men of uniform age whose activities are constant, and inter-mixing of unit groups or with civilians is held at a minimum. The criteria for admission to the sick list are constant and complete records of number of man-days exposure and respiratory disease illness are easily obtained.

The high incidence of streptococcal and other respiratory diseases at the Great Lakes Naval Training Center afforded an excellent opportunity to make controlled studies of measures thought to be effective in reduction of communicable disease.

Experimental design. The studies were conducted in two regiments of the Recruit Training Command and were effected during the 18-week period from February 3 to June 8, 1946. In each experiment a test group and a control group were formed by treating alternate barrack buildings. One regiment was used to study the effect of dust control measures alone and the other to compare the effect of ultraviolet radiation and dust control against dust control alone.

The arrangement of barracks and other buildings in the experimental area is shown in figure 1. The physical and personnel organization of these two regiments were identical in every detail. Each regiment was a self-contained unit except that a common drill hall (unradiated and unoiled) and recreation building (unradiated) served the two regiments. Each unit comprised 16 two-story barracks, housing approximately 4,000 recruits when at maximum strength. One company of 120–140 men occupied a floor of each barrack, sleeping in the one large dormitory room in double tiered bunks spaced 18 inches apart. The buildings were of frame construction, wooden-floored and each barrack room measured 100×40×11 feet.

For the dust control study[6] in the 25th Regiment the floors of alternate barracks were oiled, and oil-processed blankets were issued to personnel billeted in these barracks. The remaining barracks in this regiment, housing an equal number of recruits served as controls. The floors of class rooms, dispensary, and recreation building used by all personnel of this regiment were oiled. New high grade blankets containing 1% natural oil were processed in the station laundry by rinsing in an aqueous emulsion of a special blanket oil.* Floors of dust control barracks were treated with an oil emulsion consisting of three parts of Shell white deck oil, one-half part Roccal and 10 parts of warm water. The floors were oiled three times before beginning the experiment, once during the first month of the experiment and weekly thereafter, less frequent oiling being found ineffectual. No scrubbing of oiled floors with soap and water was allowed. This type of application left a thin film but no excess oil on the floor.

The ultraviolet radiation study was conducted in the 27th Regiment. Dust control measures were applied in all buildings of the regiment. Alternate

6. Wright, J., Cruickshank, R., and Gunn, W. 1944, Control of Dust-Borne Streptococcal Infection in Measles Wards. Brit. Med. J. **1**: 611–614.

* Developed by Naval Medical Research Unit No. 1, Captain A. P. Krueger MC(S) USNR, in charge. Formula:

Triton X-100	11.20%
Ocenol, steamed	12.68
Water	.82
Glycerine	1.00
White Oil, #5	74.30

Mix one gallon formula and one-half gallon Roccal (20%); add to 160 gallons warm water for treatment of 50 blankets.

Prepared by and purchased from Standard Oil Company of California.

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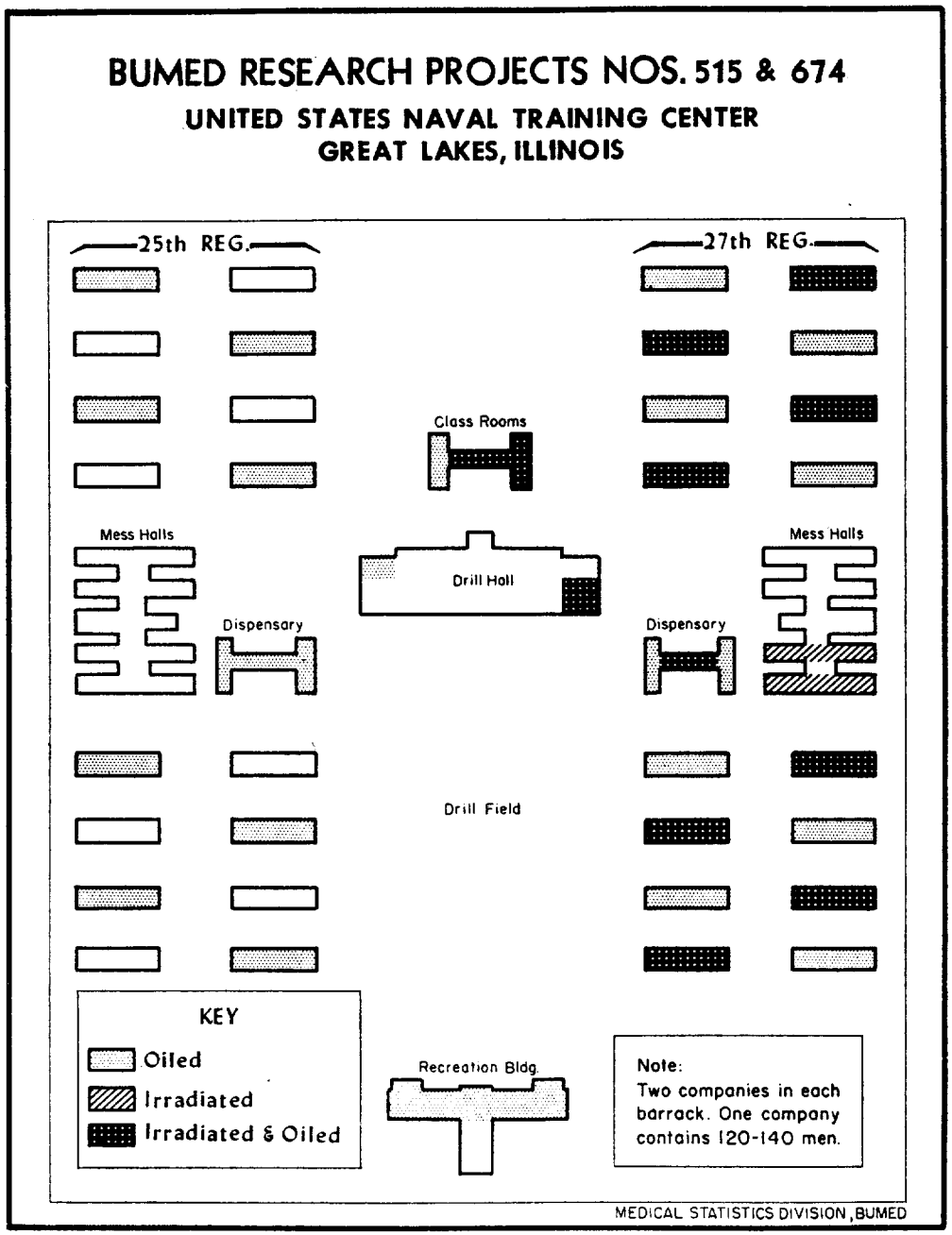

FIG. 1.—Showing the Area and Arrangement of Buildings Involved in the Ultraviolet Study.

barracks were equipped with twenty-eight 30 watt germicidal lamps in ceiling fixtures 7 feet 9 inches from the floor reflecting upward (figure 2), thirty-four 15 watt lamps in fixtures placed under alternate bunks 12 inches from the floor reflecting downward and sixteen 15 watt lamps in fixtures placed on the end

0018072

of bunks 18 inches from the floor for aisle radiation. Class rooms, dispensary waiting rooms, and one-half of the mess hall in the 27th regiment were also radiated.

The lamps were burned for 100 hours in absence of barrack occupants before the studies were begun, to obtain uniform intensity of radiation and reduce ozone production. The ultraviolet emission of lamps was measured monthly and those found inefficient were replaced. The average effective life of each lamp was about 2,500 hours. Periodic measurements were made of the intensity of scattered radiation at face-level. The amount of stray radiation to which subjects were exposed varied between 0.01 and 0.8 microwatt per sq cm but rarely above 0.5 microwatt per sq cm. Three cases of mild ultraviolet conjunctivitis occurred which were traced to careless curiosity or failure to observe warning signs. All lamps were burned 24 hours a day during the 18 weeks of the experiment. Lamps and reflectors were polished weekly with a dry cloth and cleaned monthly with alcohol.

Ninety-eight per cent of the men in recruit training were 17–21 years of age; two per cent were from 21–25. The curriculum for Recruit Training required from 8–10 weeks and consisted of a regime of indoctrination, inoculations, lectures, military drill and physical exercise.

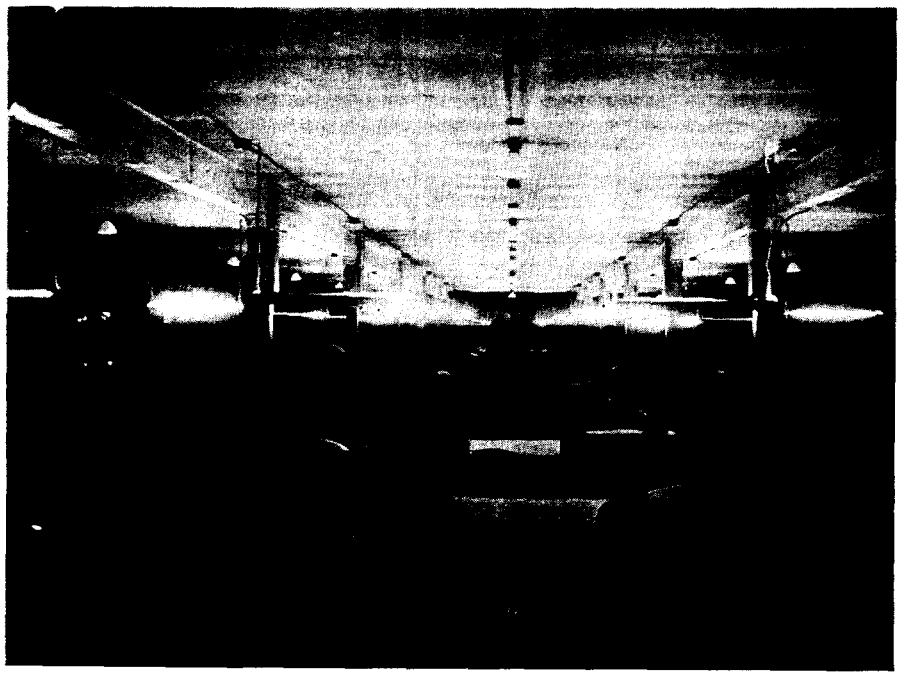

FIG. 2.—Overhead ultraviolet installations in barrack. Underbunk and aisle fixtures not shown.

The total number of companies and individuals observed in each experimental group is given in table 1.

Data collected.—The basic data was recorded by companies. The number of men present and the number of admissions to the sick list due to each of the various respiratory diseases were re-

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TABLE 1.—*Population of experimental groups.*

Group	Number of companies	Total Number of persons observed
27th Regiment		
Total	71	8,515
Irradiated and oiled	37	4,452
Oiled control	34	4,063
25th Regiment		
Total	71	8,526
Oiled	33	3,956
Untreated control	38	4,570

corded daily by company. The total number of admissions and average strengths of all companies in an experimental group gave the data for computing sick rates on that group. The usual military practice of expressing rates as the number of cases per thousand men per year was used.

It was desired to analyze the effects of the control measures on the incidence of streptococcal disease in addition to total respiratory disease. A throat culture for hemolytic streptococci was taken on each respiratory disease admission. All cases diagnosed as acute tonsillitis or pharyngitis which gave a strongly positive throat culture for hemolytic streptococci were assumed to be streptococcus disease. A strongly positive culture was arbitrarily defined as one in which 35% or more of the colonies on the plate were hemolytic streptococci. These cases combined with scarlet fever were used to evaluate the effect of the control measures on hemolytic streptococcus disease.

During April, studies were conducted to determine the effect of control measures on bacteria in air, blankets and floor dust; on hemolytic streptococcus throat carriers; and on dust in the air.

Determinations of total bacteria in air were made by exposing duplicate open agar plates during 4 periods of varying activity during day and night. A total of 1,200 plates were exposed.

Beta hemolytic streptococci were isolated from the air by bubbling 45 cu ft of air through 20 ml of broth in bubbler tubes and plating the broth on crystal violet rabbit blood agar. The critical final concentration of crystal violet sufficient to inhibit growth of most gram positive organisms without inhibiting streptococci was determined by titration to be 1 to 1,250,000.

Bacterial counts of floor dust were made by plating decimal dilutions of floor dust in plain and crystal violet blood agar.

Counts of total bacteria released from blankets by light agitation were obtained by stretching the blanket evenly on a large table and patting an inverted agar petri plate over the surface of the blanket 80 times, the blanket fibres not touching the agar. The same person made duplicate counts of 50–90 blankets from each experimental group.

The streptococcus carrier rate was determined by taking throat cultures on all men of a company chosen at random from each of the experimental groups.

Comparisons of the dust content of the air were made by counting dust particles from about 100 samples from each experimental group with a Bausch and Lomb Dust Counter.

All petri plate cultures were incubated 48 hours at 37 degrees C and counts were made on a Spencer Colony Counter.

Hemolytic streptococci isolated from carriers, and from cases of scarlet fever, streptococcus tonsillitis and pharyngitis were typed.

Stage of training factor. Observation was made in previous Navy epidemiological studies[3] and again here that there is a significant relation between the admission rate for a unit and length of time the unit has been on the station. Consequently, over-all admission rates

TABLE 2.—*Incidence of all respiratory disease for the season in the various weeks of training. (Data for figure 3).*

Week of training	Annual admission rate per thousand			
	27th Regiment		25th Regiment	
	Radiated & oiled	Oiled control	Oiled	Untreated control
1	1,062	1,007	1,428	1,778
2	1,131	1,441	2,205	2,102
3	1,666	2,176	2,815	3,225
4	2,683	2,788	4,317	4,209
5	1,912	3,521	4,527	4,380
6	2,299	2,245	3,987	3,703
7	1,284	2,202	3,010	3,266
8	1,102	1,260	2,102	1,931
9	976	954	776	1,099
10	373	927	602	275

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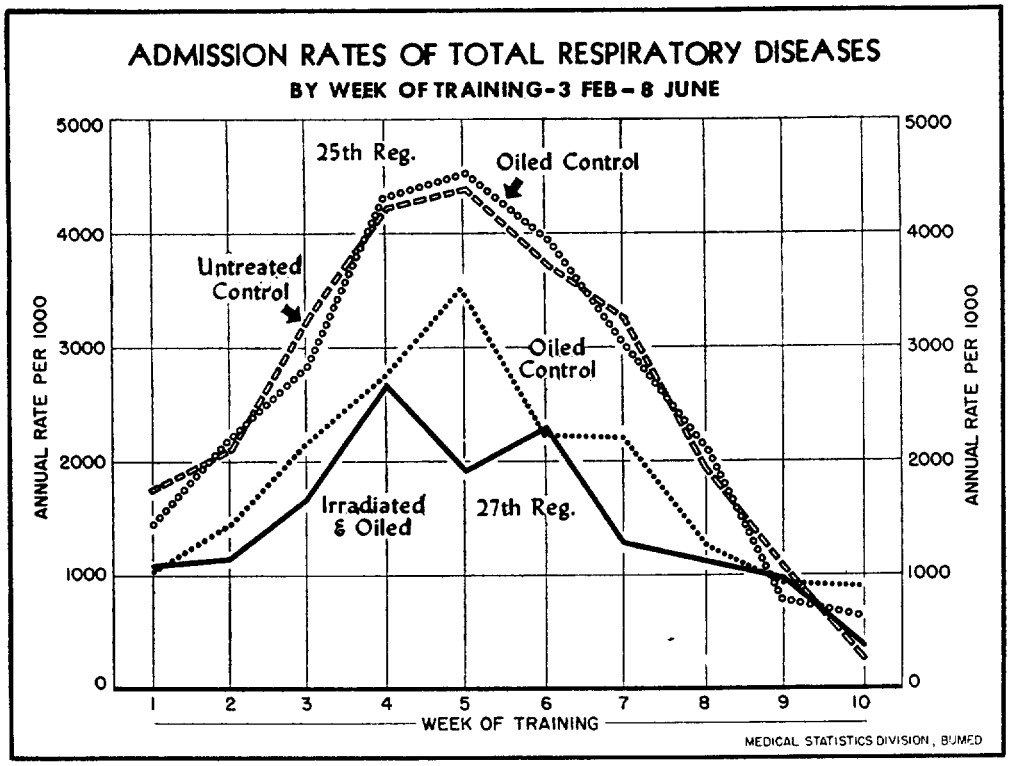

FIG. 3.—Showing admission rates per year per thousand of all respiratory diseases by week of training in the treated and control groups.

by week-of-training were computed for total respiratory disease in each of the experimental groups (table 2). The rates were low during the first two weeks of training, increased rapidly to a peak in the fourth and fifth weeks, and then declined to a low point again. From figure 3 it can be seen that this pattern was the same in both experiments, except that the radiated group showed a marked retrogression during the fifth week in contrast to the peaks of the other three groups. Similar trends were observed for both streptococcus diseases and virus diseases.

Effect of control measures on groups having high rates compared with those having low rates

Since recruits in the third to sixth week of training had the highest incidence, as noted in figure 3, it was desired to determine the effect of ultraviolet radiation in this group as compared to recruits experiencing stages of training when the rates are relatively lower, (i.e., 1st, 2nd, 7th, 8th, and 9th week of training). Results of this analysis are presented in figure 4. When overall morbidity incidence was at the peak (the 4 week period ending March 15th) a 33% difference was observed between the control group and the radiated group of third to sixth week companies. However, a moderately reverse effect was observed when the general trend of rates of the population showed a sharp decline. The two groups approached a mean and tended to level off to a seasonal endemic level.

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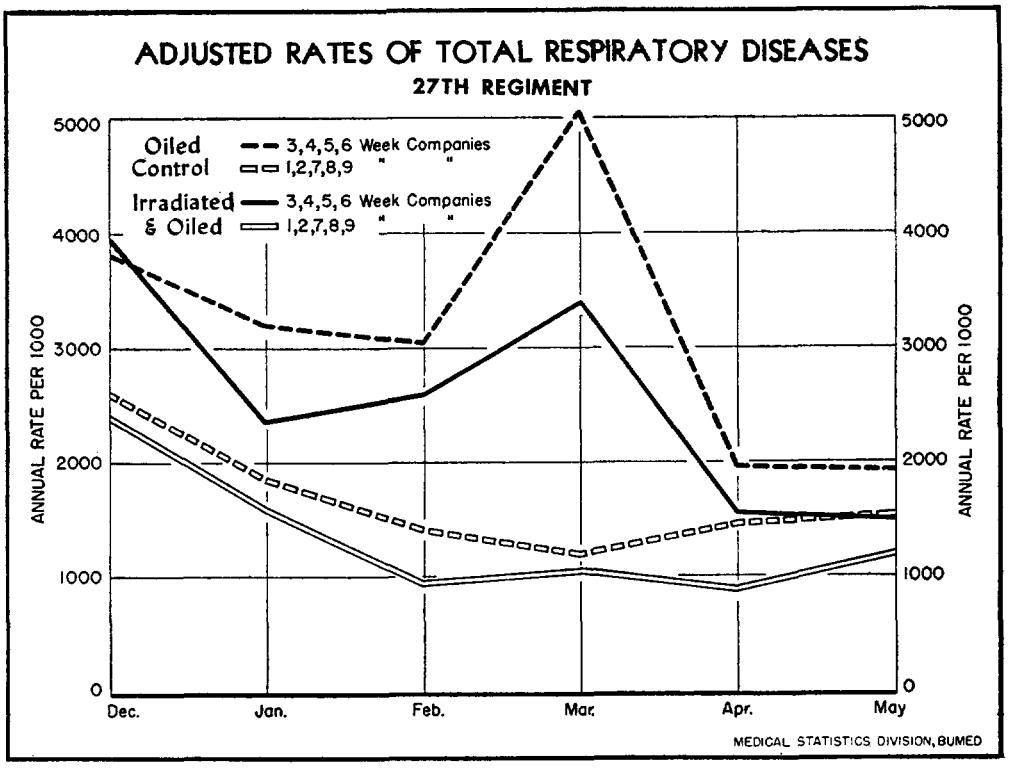

FIG. 4.—Showing the effect of ultraviolet control measures on groups having high respiratory disease rates compared with those having low rates.

Effect of control measures on incidence of respiratory disease on a chronological basis

Since the 4 experimental groups varied considerably in their composition with respect to the number of companies in each of the various weeks of training (for example see table 5), the crude admission rates were adjusted for this variable in the computation of chronological rates. The usual technique for adjusting mortality and morbidity rates to a standard population was used, with the camp-age factor (week-of-training) corresponding to year-of-age. The "standard population" was obtained by averaging the strengths in each week of training for all companies during February and March. An example of the method of adjustment of rates is given in table 6.

Annual admission rates based on 4-week averages adjusted for week-of-training variable are shown for each experimental group in table 3. Curves of the adjusted rates in the 4 experimental groups for the 18 weeks of studies are presented in figure 5.

Rates were computed for the two 4-week periods preceding the start of the experiment to show the status of the groups before application of the control measures. In December the rates in the experimental and control groups in each regiment were approximately the same but the rates were considerably higher in the 27th regiment than in the 25th regiment. Beginning in February the

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TABLE 3.—*Incidence of total respiratory disease on a chronological basis (annual admission rates per thousand adjusted for week-of-training). (Data for figure 5).*

4-week period	27th Regiment		25th Regiment	
	Radiated & oiled	Oiled control	Oiled	Untreated control
December	3,123	3,165	2,590	2,562
January	1,918	2,470	2,286	2,107
February	1,702	2,107	3,266	3,068
March	2,065	2,866	3,087	3,565
April	1,118	1,707	2,010	3,082
May*	1,394	1,720	2,521	2,061

* Includes data to 8 June: 6 week period.

rates were consistently much higher in the 25th regiment. In February the 25th regiment had a short epidemic which was not carried over to the 27th regiment. The rates were very high in all groups throughout the season.

During the month of January the ultraviolet lights were installed, tested and "burned-in" and consequently were burning 6 to 11 hours a day. During this month there was a marked drop in

TABLE 4.—*Effect of ultraviolet radiation on the incidence of total respiratory disease for the season as a whole (annual rate per thousand).*

Group	Unadjusted annual rate	Difference in unadjusted rates	Adjusted annual rate*	Difference in adjusted rates
27th Regiment				
Radiated and oiled	1,612	−20.2%	1,434	−22.6%
Oiled control	2,020		1,852	

* Adjusted for week of training.

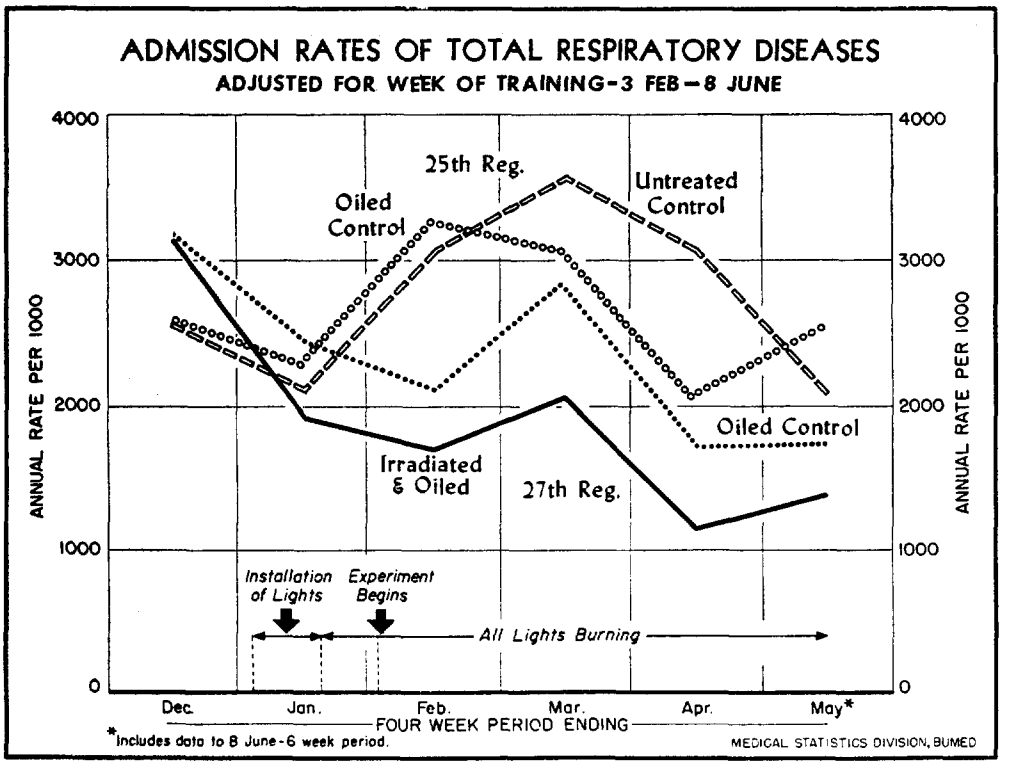

FIG. 5.—Effect of ultraviolet and dust control measures on incidence of respiratory disease shown chronologically.

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TABLE 5.—*Incidence of total respiratory infections in the 27th regiment according to stage of training, 2 February to 8 June, 1946.*

Stage of training in weeks	Frequency distribution					
	Control group (O-27)			Radiated group (OV-27)		
	Average weekly strength	Number of cases	Annual rate/1,000	Average weekly strength	Number of cases	Annual rate/1,000
1st	1,965	38	1,006	1,944	40	1,070
2nd	2,606	72	1,434	2,719	59	1,128
3rd	2,444	102	2,192	3,192	102	1,663
4th	2,768	148	2,782	3,401	175	2,676
5th	2,695	182	3,513	3,817	140	1,911
6th	3,089	133	2,240	3,675	162	2,294
7th	2,842	120	2,190	3,409	84	1,281
8th	2,575	62	1,254	3,219	68	1,099
9th	1,544	28	943	1,870	27	750
10th	337	6	925	418	3	374
Total	1,270	891	2,020	1,536	860	1,612

the admission rates of the radiated group as compared with its oiled control (27th regiment). From the beginning of the experiment (3 February) through the rest of the season the rates in the radiated group were consistently and significantly lower than the rates for the other groups.

Comparison of the oiled group in the 25th regiment with its untreated control shows that the results of dust control measures used alone were not consistent. In March and April the rates were much higher in the untreated control than in the oiled group, while in February and May the rates in the oiled group were higher. Analysis of rates for the season as a whole showed that there was no

TABLE 6.—*Camp-age specific annual rate (table 5) adjusted to a standard population, in the ultraviolet study.*

Wk. of training	Standard population		O-27 (Oiled control, 27th regiment) Specific ann. rate		
1	136	×	1,006	=	136,816
2	136	×	1,434	=	195,024
3	134	×	2,192	=	293,728
4	128	×	2,782	=	356,096
5	123	×	3,513	=	432,099
6	119	×	2,240	=	266,560
7	118	×	2,190	=	258,420
8	115	×	1,254	=	144,210
9	116	×	943	=	109,388
10	117	×	925	=	108,225
	1,242				1,242 ÷ 2,300,566 = 1,852
Adjusted annual rate O-27 1,852					
			OV-27 (Oiled & ultraviolet radiated, 27th regiment)		
1	136	×	1,070	=	145,520
2	136	×	1,128	=	153,408
3	134	×	1,663	=	222,842
4	128	×	2,676	=	342,528
5	123	×	1,911	=	235,053
6	119	×	2,294	=	272,986
7	118	×	1,281	=	151,158
8	115	×	1,099	=	126,385
9	116	×	750	=	87,000
10	117	×	374	=	43,758
	1,242				1,242 ÷ 1,780,638 = 1,434
Adjusted annual rate OV-27 1,434					

Radiated Group 1,852
Control Group 1,434
Reduction 22.6%

0018078

significant difference between the two groups.

Effect of control measures on the incidence of respiratory disease for the season as a whole

Comparison of total man day's exposure of the radiated group and its control and the incidence of total upper respiratory disease in the respective groups results in a raw unadjusted annual rate for the radiated units of 1,612; for the control of 2,020. This represents a decrease in upper respiratory infection in the radiated group of 20.2%. The stage of training factor was recognized as being probably the largest single variable as indicated above. When the over-all rates are adjusted for stage of training, a 22.6% reduction of respiratory disease is observed in the radiated group (table 4). Substantiating data are contained in tables 5 and 6.

It was realized that the true epidemiological unit was the company and not the half-regiment, it being found that the illness rate among companies varied greater than the illness rate between the half-regiment and its control. Consequently, data were subjected to further analysis employing the company as the basic epidemiological unit for determination of the significance of differences in rates observed between the experimental groups. Admission rates for total respiratory disease were computed for all companies for the total time they participated in the experiments, and then adjusted by an analysis of co-variance to take account of: date entered the experiment, stage of training at time of entry, number of days in the experiment, and average daily strength. Thus the adjusted rates provide an almost pure measure of the effects of the control measures. The use of radiation with oiling yielded a reduction of 19% in the total respiratory disease admission rate per company compared with oiling alone. This reduction was statistically significant. The analytical results are presented in table 7.

TABLE 7.—*Unadjusted and adjusted rates of total respiratory disease per basic epidemiological unit and the significance of the differences.*

Group	Average rate per company	Average adjusted rate	Difference in adjusted rates*	Probability of difference occurring due to chance alone
27th Regiment				
Radiated & oiled	1,462	1,447	−19.2%	4 in 1,000
Oiled control	1,789	1,790		
25th Regiment				
Oiled	2,742	2,651	+ 4.1%	67 in 100
Untreated control	2,477	2,549		

* As a percent of the average rate in the control group.

The results of tabulating the various respiratory diseases separately were roughly parallel to those of total respiratory disease. Due to the small numbers involved, the results were not statistically tenable. Significant, however, were those on streptococcus disease (scarlet fever plus tonsillitis and pharyngitis having strongly positive throat cultures), where a 24% reduction in the incidence of disease was observed in the radiated group.

In the 25th regiment, the use of oiling alone did not give a reduction, there being no significant difference between the experimental and control groups. However, the relative effect of floor oiling may well have been invalidated to a large degree by superb housekeeping of the unoiled control group. Faced with

0018079

TABLE 7 A.—*Comparison of the percentage reduction of total bacteria in the air under varying conditions.*

	Dust control 25th regiment oiled vs untreated	Ultraviolet radiation 27th Regiment Oiled vs oiled & radiated
Light activity	40%	87%
Average of all activity periods	51%	66%

daily inspections in competition with neat oiled floors not readily showing soil, the decks of the control groups were subjected to intense and frequent scrubbings.

RESULTS OF BACTERIAL AND DUST STUDIES

The total bacterial content of the air varied directly with the amount of activity in barracks. The percentage reduction of total bacteria in the air due to dust control measures, and to ultraviolet irradiation in the presence of dust control, is given in table 8 for each of 4 activity periods. Although ultraviolet radiation gave a greater reduction than dust control, the average reduction of all activity periods was only slightly greater with radiation than with dust

TABLE 8.—*Reduction of total bacterial content of air by dust control and ultraviolet radiation.*

	Dust control 25th regiment oiled vs untreated	Ultraviolet radiation 27th regiment oiled vs oiled and radiated
Heavy activity	56%	65%
Moderate activity	55%	61%
Sleep	33%	90%

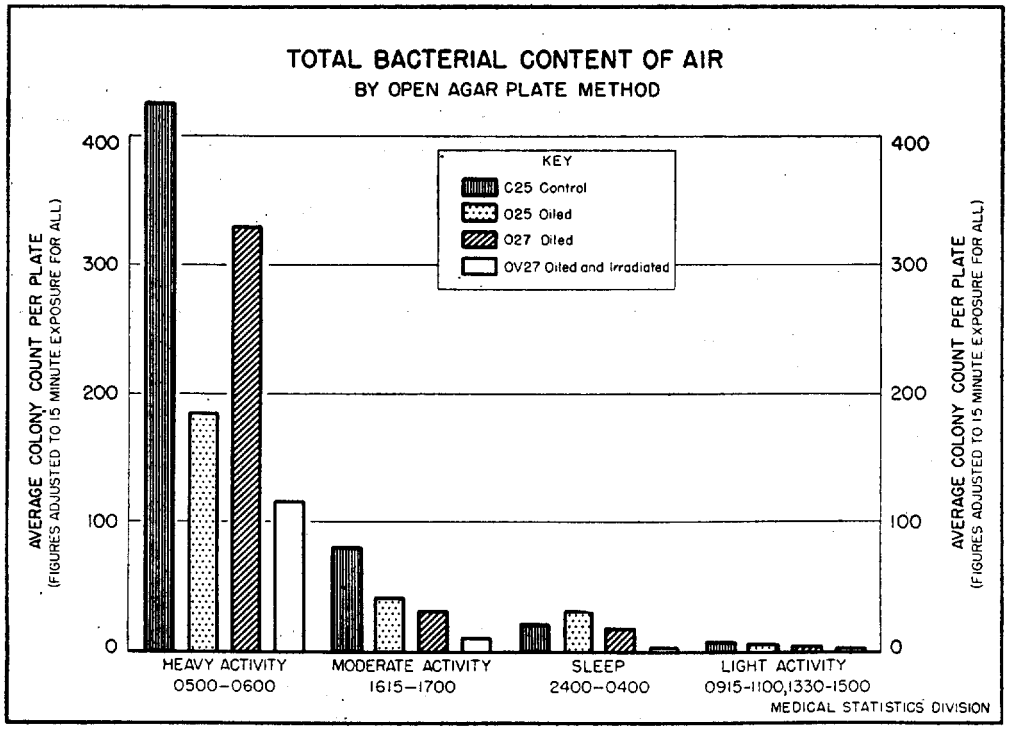

FIG. 6.—Block diagram of the bacterial content of the air taken by the open agar plate method during different parts of the day.

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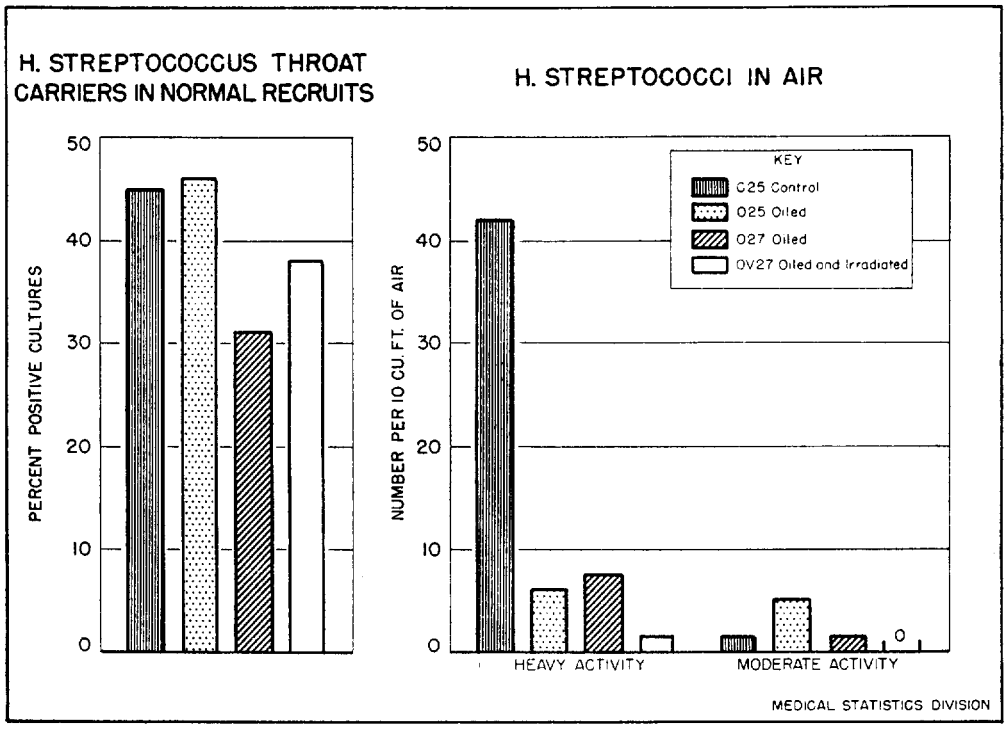

FIG. 7.—A—Per cent positive cultures of H streptococcus throat carriers in normal recruits in controlled oiled and oiled irradiated barracks.

B—Number of H streptococci per 10 cu ft of air in different types of barracks during heavy activity and moderate activity.

control alone. Graphic presentation of the average bacterial counts is shown in figure 6.

The average counts of hemolytic streptococci in the air (table 9) showed a 75% reduction due to dust control and 89% reduction due to ultraviolet radiation.

Streptococcus carrier rates among companies that had passed the third week of training varied between 40 and 55%. There was no consistent difference between experimental groups. Graphic presentation of studies of H. Streptococci in air together with incidence of streptococcal carrier rates are shown in figure 7.

TABLE 9.—*Average counts of hemolytic streptococci per 10 cu. ft. of air in barracks.*

Control, 25th Regiment	22
Oiled, 25th Regiment	5.5
Oiled control, 27th Regiment	4.5
Oiled & ultraviolet radiation, 27th Regiment	0.5

The percentage incidence of types of hemolytic streptococci found from throat carrier studies and patients is shown in table 10. The majority of entries listed as "other types A" were types 1 and 30. Types A-17 and A-19 were distinctly in the majority until late April when there was an increase in types 1, 3, and 30.

The results of the studies on the total bacterial content of dust from decks and blankets and the dust content of the air

0018081

TABLE 10.—*Percentage incidence of common types of hemolytic streptococci from cases of scarlet fever, tonsillitis and pharyngitis, and throat carriers.*

	Type A-19	Type A-17	Type A-3	Other types A	Types not A
Scarlet fever	32	25	14	16	13
Tonsillitus and pharyngitis	34	21	23	13	9
Throat carriers	28	20	21	19	12

are shown graphically in figure 8.

The average total bacterial content of floor dust was 43% less in oiled barracks than in control barracks, probably due to the fact that the oil emulsion contained an organic disinfectant (Roccal). Hemolytic streptococcus counts of the floor dust were widely variable; there was no consistent relationship between the experimental groups. The counts varied between 70,000 and 180,000 per g of dust.

The bacterial count from oiled blankets was 28% less than from unoiled blankets (25th regiment). An additional 25% reduction was observed in the blankets from radiated barracks.

Oiling floors and blankets gave a reduction of the dust content of the air of 31% during heavy activity, 43%

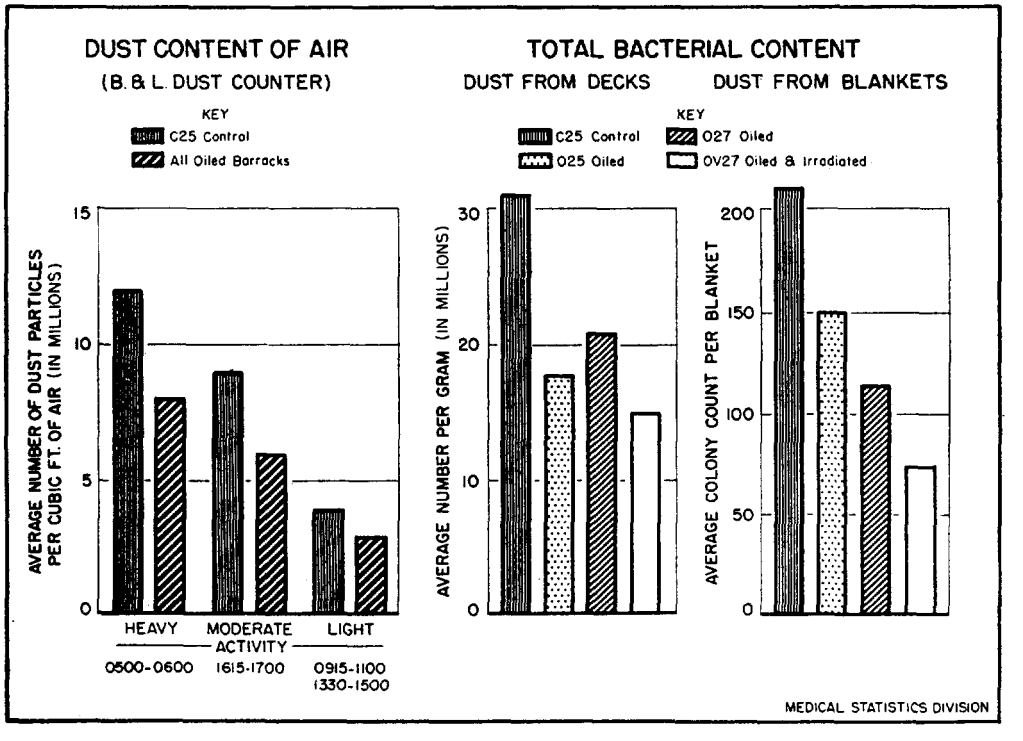

FIG. 8.—A—Average number of dust particles per 10 cu ft of air in controlled and oiled barracks during heavy, moderate and light activity.

B—Average number of cacteria per gram of sweeping dust in different types of barracks.

C—Average colony count per blanket in dust obtained from blankets in different types of barracks.

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during moderate activity, and 13% during light activity. The overall average reduction was 31%.

It is to be pointed out that all air-borne bacterial and dust counts must be accepted with caution because of the variability of all sampling methods, the marked and rapid fluctuation of bacterial population and the ease of influence of results due to normal and induced air movement.

DISCUSSION

In these studies each experimetnal test group and its control were within one regiment, and to be conservative no attempt was made to compare rates of respiratory disease in one regiment with those in the other. About 35 companies (basic epidemiological units) passed through each experimental group during the season. The rates of the two groups within each regiment appeared to be the same before the experiment was initiated (adjusted rates in December) and were roughly parallel throughout the season. There were moderate differences in the two groups in the 25th regiment which however could not be ascribed to the control measures. On the other hand, the differences between the two groups in the 27th regiment were large, consistent, and highly significant statistically. The 19% reduction due to radiation compares favorably with the 25% and 18% reductions obtained in the two years' study at Sampson Naval Training Center.[3]

The reduction of respiratory disease possible by any air-borne control measure depends on the degree to which air-borne transmission is responsible for disease production. Our knowledge of the relative importance of air, fomites, hands, and other contact, in the transmission of respiratory disease is amazingly meager.

The high incidence of streptococcal disease and carriers and the prevalence of the organisms in the environment was noteworthy during this study. Since sulfonamide resistant strains were widespread, most cases of streptococcus disease were treated by penicillin. It is interesting that in spite of this and the fact that no sulfonamide prophylaxis had been given for over one year, the majority of types A-19 and A-17 still retained resistance to sulfonamides.

The marked variation in rates of respiratory disease in various weeks of training was the most important extraneous variable entering into the experiment. It would appear that this occurrence is essentially the result of introducing a highly susceptible civilian into a military training camp having high endemic and hemolytic streptococcus carrier rates. The cycle of time and opportunity for exposure; almost inevitable infection, with acquired temporary immunity, seemed to operate in the case of each new company entering the camp.

By the seventh week of training nearly 50% of the men had experienced one or more episodes of acute respiratory disease requiring admission to the sick list. By the eighth and ninth week of training the great majority of the men probably had developed a temporary immunity after clinical or sub-clinical attacks of one or more respiratory infections. This "seasoning" would seem to be the most logical explanation for the low rates in the last stage of training.

The dust control measures produced a significant reduction in bacterial content of the air, blanket dust, and floor dust, but did not produce a consistent reduction in disease rates. The bacterial reduction compared favorably, although quantitatively somewhat less, with results reported by Thomas and Van Den Ende,[5] Robertson, et al.,[2] and others. As previously mentioned, the superb cleaning and scrubbing of the control

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