

THE USE OF TRIETHYLENE GLYCOL VAPOR FOR CONTROL OF ACUTE RESPIRATORY DISEASES IN NAVY RECRUITS

II. EFFECT ON ACUTE RESPIRATORY DISEASES¹

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The method of vaporizing triethylene glycol (TEG) in Navy recruit barracks was described in a previous report (1). Adequate saturation of the air with TEG and thorough distribution in the dormitories were maintained. In lower test dormitories the concentration of TEG vapor generally exceeded 2.5 micrograms per liter of air, and in upper test dormitories the level was usually less. Temperature and relative humidity were within the range for maximal bactericidal activity. A 65 per cent average reduction in air-borne bacteria was demonstrated.

As a further measure of the effectiveness of TEG vapor, the occurrence of

acute respiratory diseases was determined in the recruits included in the study. The results indicate that TEG vapor was not effective in preventing respiratory diseases.

POPULATION

The study was conducted among male recruits living in two barracks in the Tenth Regiment, Recruit Training Command, United States Naval Training Center, Great Lakes, Ill., from September 7, 1950, to April 3, 1951. The men arrived at the station in small groups and within 24 hours were assigned to companies of 60 men (80 men in 1951). Four companies of recruits lived in each

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Command, U. S. Naval Training Center, Great Lakes, and requesting copies of Research Report NM 005 051.05.02.

The opinions expressed herein are those of the authors and cannot be construed as reflecting the views of the Navy Department or of the Naval Service at large.

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TABLE 1

Chronological periods of observation of companies of Navy recruits in the triethylene glycol (TEG) study, U. S. Naval Training Center, Great Lakes, Ill.

Barrack	Period of observation		Company number			
			Dormitory			
	From	To	Lower		Upper	
			TEG	Control	TEG	Control
A	9/7/50	11/16/50	1	2	3	4
B	10/21/50	12/19/50	5	6	7	8
A	12/1/50	2/2/51	9	10	11	12
B	1/8/51	3/12/51	13	14	15	16
A	2/5/51	4/3/51	17	18	19	20

barrack and entered a 9- to 11-week training period at the same time. The activities of the men were integrated as a company and contact with men from other companies was limited (2). A total of 20 companies was assigned to the barracks. The companies were numbered 1 through 20. Odd-numbered companies lived in dormitories treated with TEG vapor while even-numbered companies lived in control dormitories at the opposite end of the barracks. The periods of observation are shown in table 1.

A total of 1,375 recruits entered the study companies. Clinical and serological data were incomplete in 38 men transferred from the companies during the early weeks of training for administrative reasons. Eight additional men from test companies and 7 from control companies were transferred to the United States Naval Hospital with respiratory illnesses. After exclusion of the above men, a study population of 1,322 men remained.

Test and control companies were composed of men between the ages of 17 and

24 years. The mean age was 19 years in both groups. Approximately equal numbers of men in test and control companies had had measles, mumps, scarlet fever and tonsillectomy in the past. There was no consistent difference in geographical origin between the men of test and control companies. (See table 2.)

METHODS

Clinical

Each man was examined weekly throughout his training. At these examinations, conducted in the barracks, the statement of the man as to the presence or absence of symptoms referable to the respiratory tract was accepted as the primary evidence of a respiratory infection. In an attempt to promote accurate reporting, no benefit or penalty could be derived by the man as a result of his statement. All laboratory tests were conducted without regard to symptoms. Every effort was made to avoid influencing attendance at sick call. The information obtained at the weekly examinations was supplemented by that obtained at the regimental infirmary.

Weekly examinations. Weekly examinations were conducted by 3 medical officers of Naval Medical Research Unit No. 4 who rotated between companies each week. The medical officer examined the throat, palpated the cervical lymph nodes and questioned each recruit concerning symptoms of a respiratory disease. Oral temperature and nose and throat cultures were obtained on each man. Blood specimens were collected at the first, middle and final examinations.

Infirmary. Recruits presenting themselves at the regimental infirmary complaining of respiratory disease symptoms were seen by a medical officer of

TABLE 2

Certain elements of past medical history and geographic areas of origin of men in triethylene glycol (TEG) study, U. S. Naval Training Center, Great Lakes, Ill.

Dormitory	TEG conc. in $\mu\text{g./L.}$ air	Company	Percentage of men in companies							Total number of men	
			Past history				Geographic origin*				
			Measles	Mumps	Scarlet fever	Tonsillectomy	I	II	III		
Lower	>2.5	1	90	68	8	51	35	8	57	59	
		5	87	55	9	49	36	32	32	63	
		9	84	63	16	37	40	39	21	62	
		13	83	69	8	41	81	0	19	76	
		17	88	69	25	46	58	14	28	76	
		Totals	86	65	14	45	52	18	30	336	
	0	2	89	66	9	47	6	7	87	55	
		6	89	67	12	42	39	34	27	64	
		10	83	49	7	35	59	14	27	59	
		14	92	70	14	35	38	0	62	77	
		18	91	54	8	56	32	61	7	78	
		Totals	89	61	10	44	35	25	40	333	
	Upper	<2.5	3	80	62	16	31	40	0	60	55
			7	93	53	15	45	38	24	38	58
11			89	60	15	52	32	60	8	60	
15			89	78	19	36	92	1	7	75	
19			87	56	13	47	21	64	15	78	
Totals			88	62	16	42	45	31	24	326	
0		4	86	71	7	41	5	14	81	58	
		8	86	58	14	41	41	44	15	64	
		12	83	62	5	57	50	12	38	58	
		16	88	75	14	43	42	0	58	72	
		20	89	59	15	49	47	44	9	75	
		Totals	86	65	11	46	38	23	39	327	

* I = Minnesota, Wisconsin, Illinois, Michigan, Indiana, Ohio. II = New York, Pennsylvania, New Jersey, Massachusetts, Connecticut, Maine, New Hampshire, Rhode Island. III = Southern and Southeastern States.

the unit. A medical department order required that all patients with a temperature of 100 F or over be admitted to the infirmary. Others were admitted at the discretion of the medical officer or were treated as outpatients.

Nose and throat cultures were obtained on all men visiting the infirmary with a respiratory disease. Blood specimens were collected from all admitted

patients. Nasal washings for isolation of influenza viruses were taken on selected patients suspected of having influenza.

Laboratory tests

Nose and throat cultures. A modified * Pike technique was used for isolation

* Omission of crystal violet and incubation of the broth for only 4 hours.

of beta hemolytic streptococci (3). Beta hemolytic streptococci were grouped and typed according to the method of Swift, Wilson and Lancefield (4).

Serology. Hemagglutination titers for influenza were determined on all sera according to the method of Hirst and Pickels (5). The antigens used were FM-1, PR-8 and Lee. Antistreptolysin O titers were determined on all sera by the method of Massell (6).

Diagnostic criteria

Influenza. This diagnosis was based entirely on a 4-fold rise in the Hirst hemagglutination titer. An acute respiratory illness occurring in relation to the titer rise was arbitrarily diagnosed as influenza and not counted elsewhere.

Streptococcal infection. This diagnosis was made on the basis of (a) an antistreptolysin O rise⁵ or (b) the iso-

⁵ A diagnostic rise of the antistreptolysin O titer was defined as 0.5 logarithmic increase in

lation of group A streptococci in the presence of an exudative tonsillitis-pharyngitis.

In the absence of a diagnostic rise in antistreptolysin O titer, a diagnosis of probable streptococcal infection was made when (a) a nonexudative respiratory infection occurred with simultaneous appearance of a group A streptococcus or (b) a new type of group A streptococcus appeared and persisted in following cultures.

Respiratory infection of unknown etiology. This diagnosis was made for an acute respiratory illness which could not be identified by available bacteriologic or serologic data and included such clinical entities as the common cold, pharyngitis, bronchitis and rhinitis.

titer if initial titer was 63 or less; a 0.4 logarithmic increase if initial titer was 63 to 125; and a 0.3 logarithmic increase if initial titer was 160 or greater.

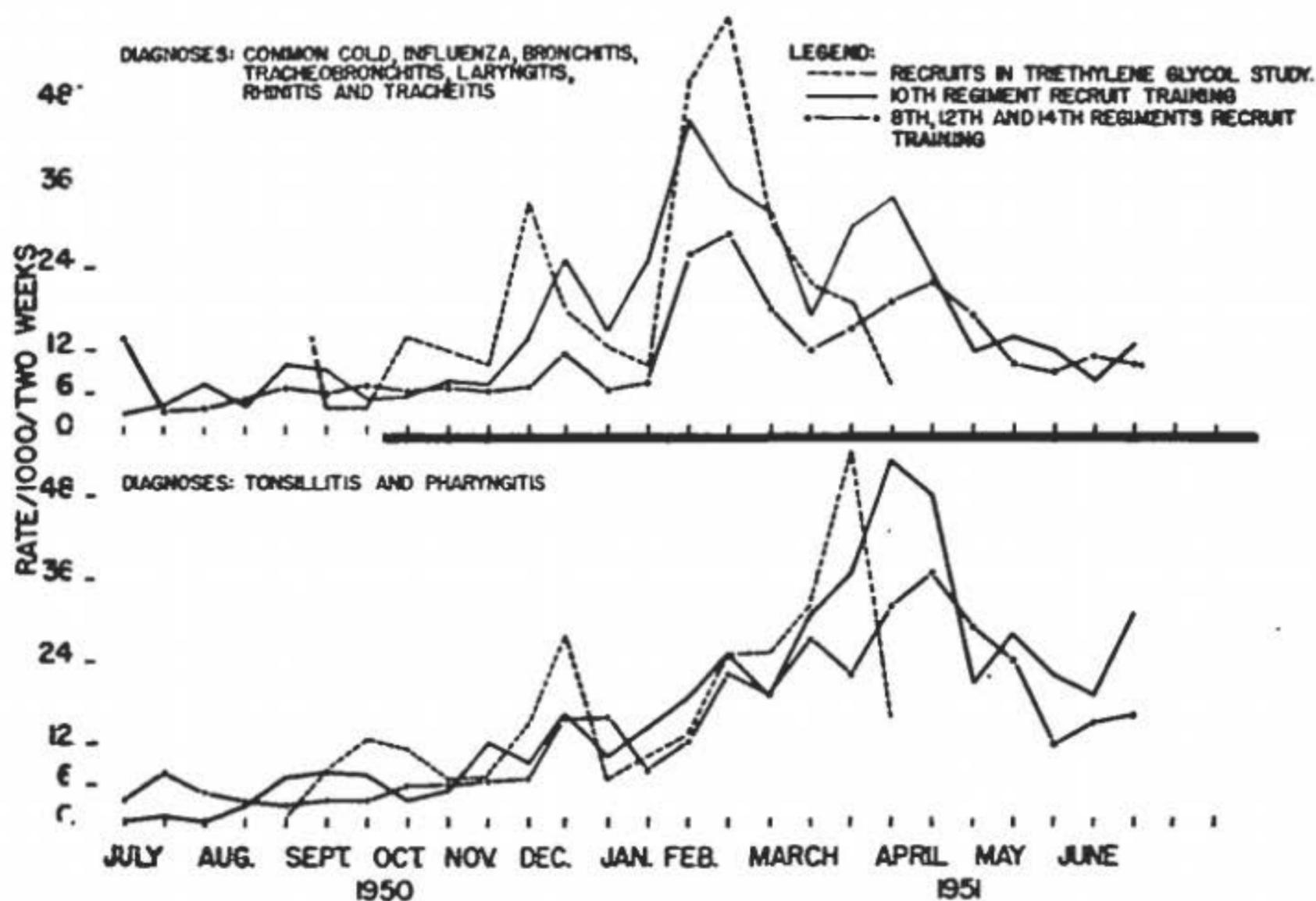


FIGURE 1. Admission rates for acute respiratory diseases, excluding pneumonias and communicable diseases in Navy recruits, United States Naval Training Center, Great Lakes, Ill.

TABLE 3

Influenza in Navy recruits in the triethylene glycol (TEG) study, October, 1950, to April, 1951, U. S. Naval Training Center, Great Lakes, Ill. (Four-fold rise in titer by Hirst method to FM-1, PR-8 or Lee strains of influenza virus required for diagnosis)

Dormitory	Company no.	TEG*			Company no.	Control		
		Number		Per cent with influenza		Number		Per cent with influenza
		In company	With rise			In company	With rise	
Lower	5	63	0	0.0	6	64	2	3.1
	9	62	5	8.0	10	59	2	3.3
	13	76	20	26.3	14	76	15	19.4
	17	76	6	7.8	18	78	17	21.7
	Totals	277	31	11.1	Totals	278	36	12.9
Upper	7	58	1	1.7	8	64	1	1.5
	11	60	3	5.0	12	58	4	6.8
	15	75	21	28.0	16	72	21	29.1
	19	78	11	14.1	20	75	14	18.6
	Totals	271	36	13.2	Totals	269	40	14.8

* Concentration in dormitories: lower $>2.5\mu\text{g.}$; upper $<2.5\mu\text{g.}$ TEG/L. air.

Epidemiological background

The admission rates for respiratory diseases in the entire recruit population are shown in figure 1. The admissions were grouped according to the clinical diagnosis assigned by the admitting medical officer to differentially show the rates for those diagnosed as tonsillitis or pharyngitis from other respiratory diseases. These diagnoses were made by various medical officers without relation to etiology or the presence of exudate.

The admission rates were low throughout the last months of 1950. In January and February, 1951, a sharp increase in the rates for illnesses, clinically diagnosed as the common cold, occurred in all 4 regiments of recruit training. During this outbreak the occurrence of influenza was demonstrated by isolations of A-prime influenza virus and serologic evidence in recruits from the Tenth

Regiment and study companies. The admission rate of recruits with acute tonsillitis or pharyngitis increased rapidly during February and March, while the incidence of influenza was still high. This coincided with an increasing frequency of isolation of beta hemolytic streptococci from the cultures of men admitted from the Tenth Regiment. Beta hemolytic streptococci were isolated from 30 to 40 per cent of the men admitted from this regiment in March.

The admission rates from study companies were similar to that observed for the entire recruit population.

RESULTS

Influenza. A total of 143 men were diagnosed as having influenza (table 3). Influenza was not diagnosed in the first 4 companies. In the next 8 companies only 18 cases occurred and these were evenly divided between test and control groups. Influenza was present in epi-

TABLE 4

Group A streptococcal infections in Navy recruits in triethylene glycol (TEG) study, October, 1950, to April 1951, U. S. Naval Training Center, Great Lakes, Ill.

Dormi- tory	Company no.	TEG*				Company no.	Control			
		Number			Per cent† with strep. inf.		Number			Per cent† with strep. inf.
		In company	With strep. inf.				In company	With strep. inf.		
			Definite	Probable				Definite	Probable	
Lower	5	63	2	3	7.9	6	64	8	0	12.5
	9	62	2	5	11.2	10	59	4	6	16.7
	13	76	26	13	51.3	14	77	15	7	28.5
	17	76	22	4	34.2	18	78	37	10	60.2
	Totals	277	52	25	27.8	Totals	278	64	23	34.8
Upper	7	58	1	0	1.7	8	64	10	3	20.3
	11	60	4	1	8.3	12	58	0	6	10.3
	15	75	10	13	30.7	16	72	15	9	33.3
	19	78	15	7	28.2	20	75	22	11	44.0
	Totals	271	30	21	18.8	Totals	269	47	29	28.3

* Concentration in dormitories: lower $>2.5 \mu\text{g.}$; upper $<2.5 \mu\text{g.}$ TEG/L. air.

† Includes probable streptococcal infections.

demic proportions in all but one (company 17) of the last 8 companies.

Streptococcal infections. Streptococcal infections did not occur in men in the first 4 companies. In the remaining 1,095 men, 203 streptococcal infections and 116 probable streptococcal infections were diagnosed. Of the 319 infections, 28 were reinfections and 72 occurred less than 2 weeks before the final blood specimen was collected. A diagnostic rise in antistreptolysin O titer occurred in 59 per cent of the remaining 219 men.

The number of streptococcal infections in companies 5 through 12 was small (table 4). In companies 13 through 20 the number of streptococcal infections was greatly increased. In companies 13 through 16 the highest incidence of streptococcal infections occurred in men living in the lower test

dormitory. In the last 4 companies the highest incidence occurred in men in the lower control dormitory. TEG vapor did not prevent intracompany epidemics of streptococcal infections. A consistent reduction in the number of infections was not observed in comparison of test and control companies.

A marked variation in the distribution of types of group A streptococci occurred between companies, but type 14 was generally predominant (table 5). A type 18 streptococcus predominated in control companies 18 and 20, but was not isolated from men in test companies 17 and 19 and accounted for the major difference in the number of positive cultures between these companies.

The behavior of type 14 streptococci in companies 13 through 16 demonstrated the inability of TEG vapor to

TABLE 5

Distribution of beta hemolytic streptococci recovered from nose and throat cultures* obtained from Navy recruits in triethylene glycol (TEG) vapor study at time of last examination during training. (Companies 13, 14, 15 and 16 were cultured on March 12, 1951, and 17, 18, 19 and 20 on April 2, 1951.)

Com- pany no.	TEG conc. µg./L. air in dorm.	Number of cultures positive for beta hemolytic streptococci														Total positive	Number of men in company
		Group A type												Not group A			
		5		6		10/12		14		18		Other		T	N&T		
		T	N&T	T	N&T	T	N&T	T	N&T	T	N&T	T	N&T				
13	>2.5	1	0	1	1	0	0	4	13	0	0	1	0	4	1	26	76
14	0	3	2	1	0	0	0	1	11	0	0	1	0	3	0	22	77
15	<2.5	2	1	0	0	0	0	4	8	0	0	2	4	1	0	22	75
16	0	0	1	3	5	0	1	1	3	0	0	1	0	9	2	26	72
17	>2.5	1	1	4	4	1	1	5	2	0	0	3	1	4	0	27	76
18	0	0	4	3	2	1	0	7	5	18	9	0	0	2	2	53	78
19	<2.5	1	0	0	1	0	0	13	10	0	0	2	0	1	1	29	78
20	0	1	0	1	0	3	0	4	5	6	6	0	0	3	0	29	75

* Subdivided as to whether both nose and throat (N&T) cultures were positive or only throat (T) cultures were positive.

LEGEND:

% MEN	TEG CONCENTRATION PER LITER OF AIR	COMPANY NO.	NO. MEN
—•—•—	2.5 µg OR MORE	13	76
—••••—	NONE	14	77
—•••••	2.4 µg OR LESS	15	75
—•••••	NONE	16	72

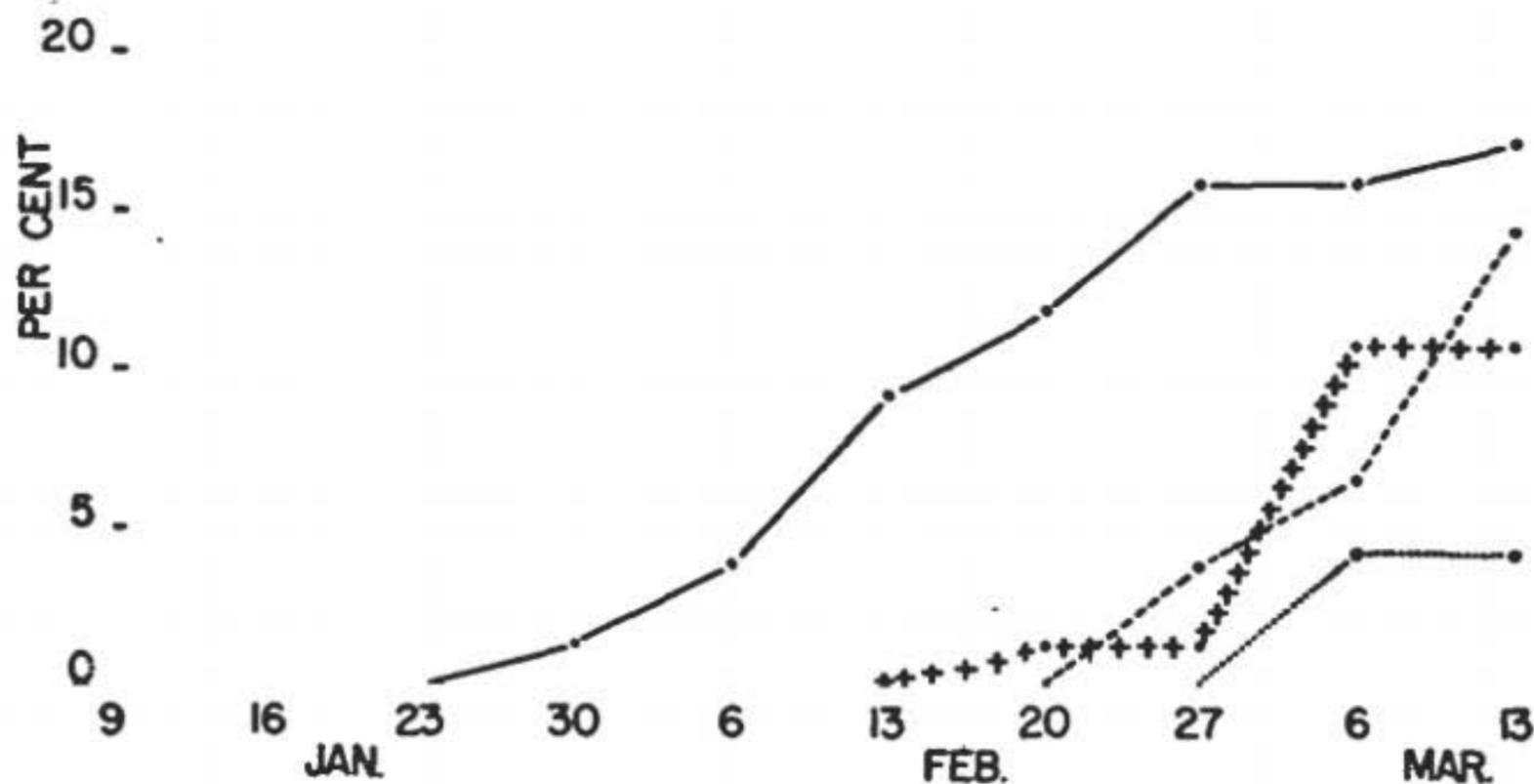


FIGURE 2. Positive nose and throat cultures for type 14 streptococci isolated at weekly examinations in Navy recruits in triethylene glycol study, U. S. Naval Training Center, Great Lakes, Ill.

TABLE 6

Respiratory infections of unknown etiology (RIUE) in Navy recruits in triethylene glycol (TEG) study, September, 1950, to April, 1951, U. S. Naval Training Center, Great Lakes, Ill.

Dormi- tory	TEG*								Control							
	Com- pany no.	Number of men							Com- pany no.	Number of men						
		In co.	Cont. sym.†	With- out RIUE	With RIUE					In co.	Cont. sym.†	With- out RIUE	With RIUE			
					Number								Number			
				1	2	3	Total					1	2	3	Total	
Lower	1	59	10	6	24	12	7	43	2	55	7	6	18	17	7	42
	5	63	9	14	24	13	3	40	6	64	7	9	28	13	7	48
	9	62	3	10	19	19	11	49	10	59	11	5	18	15	10	43
	13	76	16	30	23	5	2	30	14	77	20	20	24	9	4	37
	17	76	12	22	22	16	4	42	18	78	7	26	30	10	5	45
	Totals	336	50	82	112	65	27	204	Totals	333	52	66	118	64	33	215
Upper	3	55	8	9	21	13	4	38	4	58	9	11	19	15	3	37
	7	58	9	10	24	14	1	39	8	64	5	14	29	14	2	45
	11	60	6	5	24	18	7	49	12	58	13	10	19	12	4	35
	15	75	12	24	25	9	5	39	16	72	12	20	24	13	3	40
	19	78	7	16	34	17	4	55	20	75	5	25	25	17	2	44
	Totals	326	42	64	128	71	21	220	Totals	327	44	80	116	71	14	201

* Concentration in dormitories: lower >2.5 $\mu\text{g.}$; upper <2.5 $\mu\text{g.}$ TEG/L. air.

† Cont. sym. = continuously symptomatic.

prevent intracompany spread of streptococci. Company 13 occupied a dormitory treated with a concentration of TEG ranging from 2.5 to 10 micrograms per liter of air under optimal conditions of temperature and relative humidity. In addition, the floors of both test and control lower dormitories were oiled on February 14, following which total bacterial counts from the air were even more markedly reduced (1). (See figure 2.)

Type 14 streptococci were first isolated from nose and throat cultures in company 13 at the fourth examination. The number of positive cultures increased each week thereafter. An intracompany epidemic of type 14, group A streptococcal infections occurred and

37 per cent of the men in the company became infected. In companies 14, 15 and 16 where type 14 did not appear until later, the respective percentages of men infected with this type were 14, 12 and 4.

Acute respiratory infections of unknown etiology. Seven hundred and six men had a respiratory infection upon entering the barracks and 245 men had a respiratory infection during the first week of training. Since the exposure to the etiological agents may have occurred prior to entry of the men into the barracks, these infections were not included in the results. At all examinations 188 (14 per cent) of the men reported continuing symptoms, usually those of rhinitis or cough. These men were ex-

cluded in the tabulation of the results because of the difficulty in distinguishing new infections from exacerbations of continuing symptoms.

Respiratory infections of unknown etiology occurred in 74 per cent of the men in test companies and 74 per cent of the men in control companies. Multiple infections occurred in approximately equal numbers of men from the test and control companies. The largest variation in the number having multiple infections occurred between the two control groups (table 6).

Prophylactic action of TEG vapor against respiratory infections should best be observed in men who were free of respiratory infections upon entry into the environment.

Of the 371 men asymptomatic during the first week, 78 per cent in test companies and 73 per cent in control companies developed one or more respiratory infections of unknown etiology (table 7). The variation between individual companies was appreciable and occurred between control companies as well as between test and control companies.

Other illnesses. There were 8 men with primary atypical pneumonia, 2 with rheumatic fever and 4 with measles. More than one case of primary atypical pneumonia or measles did not occur in any one company.

Only 41 men remained free of all types of acute respiratory infections. Of these, 21 were in test and 20 were in control companies.

TABLE 7

Respiratory infections of unknown etiology (RIUE) in Navy recruits who remained asymptomatic for 1 week or more following entry into barrack in triethylene glycol (TEG) study, September, 1950, to April, 1951, U. S. Naval Training Center, Great Lakes, Ill.

Dormi- tory	TEG*							Control						
	Company no.	Number of men						Company no.	Number of men					
		In company	Without RIUE	With RIUE					In company	Without RIUE	With RIUE			
				Number							Number			
			1	2	3	Total			1	2	3	Total		
Lower	1	17	1	7	5	4	16	2	20	2	8	7	3	18
	5	18	6	4	7	1	12	6	21	4	9	5	3	17
	9	15	2	5	5	3	13	10	16	0	4	9	3	16
	13	11	4	5	1	1	7	14	9	4	0	3	2	5
	17	26	8	6	10	2	18	18	26	7	11	5	3	19
	Totals	87	21	27	28	11	66	Totals	92	17	32	29	14	75
Upper	3	10	4	2	3	1	6	4	12	3	3	4	2	9
	7	13	3	7	2	1	10	8	28	9	14	4	1	19
	11	25	2	11	9	3	23	12	15	5	1	6	3	10
	15	12	3	4	3	2	9	16	17	8	4	5	0	9
	19	32	6	14	11	1	26	20	28	10	11	6	1	18
	Totals	92	18	38	28	8	74	Totals	100	35	33	25	7	65

* Concentration in dormitories: lower $>2.5 \mu\text{g.}$; upper $<2.5 \mu\text{g./L.}$ air.

TABLE 8

Navy recruits from triethylene glycol (TEG) study treated as outpatients at the regimental infirmary for influenza (I), streptococcal infections (SI) and acute respiratory infections of unknown etiology (RIUE), U. S. Naval Training Center, Great Lakes, Ill.

Dormitory	TEG*						Control					
	Company no.	Number of men	Number treated				Company no.	Number of men	Number treated			
			I	SI	RIUE	Total			I	SI	RIUE	Total
Lower	1	59	0	0	14	14	2	55	0	0	3	3
	5	63	0	0	12	12	6	64	0	1	11	12
	9	62	1	2	9	12	10	59	0	0	7	7
	13	76	4	2	5	11	14	77	4	2	19	25
	17	76	0	3	15	18	18	78	2	9	5	16
	Totals	336	5	7	55	67	Totals	333	6	12	45	63
Upper	3	55	0	0	7	7	4	58	0	0	5	5
	7	58	0	0	10	10	8	64	0	0	16	16
	11	60	3	1	19	23	12	58	2	0	9	11
	15	75	4	5	19	28	16	72	3	1	5	9
	19	78	2	4	12	18	20	75	3	3	10	16
	Totals	326	9	10	67	86	Totals	327	8	4	45	57

* Concentration in dormitories: lower $>2.5 \mu\text{g.}$; upper $<2.5 \mu\text{g./L.}$ air.

Infirmiry observations. The number of men with respiratory infections treated as outpatients at the regimental infirmary varied considerably from company to company (table 8). More men voluntarily reported to the infirmary because of respiratory infections from test companies.

From the study companies there were 233 admissions for respiratory infections. Of these, 46 per cent were from test companies. The number of admissions also varied considerably between individual companies (table 9).

There was no constant relation between the number of respiratory infections derived from information at the weekly examinations and the number of respiratory infections encountered in men who voluntarily sought treatment at the infirmary (table 10). Pronounced variations occurred in those infections

diagnosed as influenza or as being due to beta hemolytic streptococci.

DISCUSSION

Previous studies of the value of triethylene glycol (TEG) vapor for the control of respiratory infections have yielded contradictory results.

Harris and Stokes (7) used propylene and later triethylene glycol in a children's convalescent home from 1941 to 1944. The children were in the wards most of the time and there were few outside contacts. Marked reductions in total air-borne bacteria and respiratory infections were reported.

Contradictory clinical results were obtained in studies conducted on infants' hospital wards. Loosli et al. (8) reported that although a 31 to 70 per cent reduction in air-borne bacteria was obtained by TEG and dust suppressive

TABLE 9

Navy recruits from triethylene glycol (TEG) study admitted to the regimental infirmary for influenza (I), streptococcal infection (SI) and acute respiratory infections of unknown etiology (RIUE), U. S. Naval Training Center, Great Lakes, Ill.

Dormitory	TEG*						Control					
	Company no.	Number of men	Number treated				Company no.	Number of men	Number treated			
			I	SI	RIUE	Total			I	SI	RIUE	Total
Lower	1	59	0	0	8	8	2	55	0	0	2	2
	5	63	0	0	2	2	6	64	0	0	8	8
	9	62	0	2	9	11	10	59	0	0	4	4
	13	76	7	5	4	16	14	77	5	10	13	28
	17	76	3	11	7	21	18	78	1	15	11	27
	Totals	336	10	18	30	58	Totals	333	6	25	38	69
Upper	3	55	0	0	3	3	4	58	0	0	2	2
	7	58	0	0	4	4	8	64	0	3	6	9
	11	60	0	0	7	7	12	58	0	0	5	5
	15	75	6	1	6	13	16	72	7	3	5	15
	19	78	5	7	11	23	20	75	4	9	12	25
	Totals	326	11	8	31	50	Totals	327	11	15	30	56

* Concentration in dormitories: lower $>2.5 \mu\text{g.}$; upper $<2.5 \mu\text{g./L.}$ air.

TABLE 10

Percentage of respiratory infections diagnosed by weekly examination of Navy recruits in the triethylene glycol (TEG) study, treated as outpatients or admitted to regimental infirmary, U. S. Naval Training Center, Great Lakes, Ill.

Dormitory	Diagnosis	TEG*			Control		
		Number of infections	Per cent		Number of infections	Per cent	
			Outpatients	Admitted		Outpatients	Admitted
Lower	RIUE†	335	16	9	345	13	11
	Influenza	31	16	32	36	17	17
	Strep. inf.	85	8	21	98	12	26
	Totals	451	15	13	479	13	14
Upper	RIUE†	332	20	9	300	15	10
	Influenza	36	25	31	40	20	28
	Strep. inf.	56	18	14	80	5	19
	Totals	424	20	12	420	14	13

* Concentration in dormitories: lower $>2.5 \mu\text{g.}$; upper $<2.5 \mu\text{g./L.}$ air.

† RIUE = respiratory infections of unknown etiology.

measures, extensive dispersal of beta hemolytic streptococci with resulting cross infections occurred. More recently, Krugman and Ward (9) observed the effect of TEG vapor on cross infections of acute respiratory diseases and measles. During the first winter fewer cross infections occurred on TEG treated wards, but the results were reversed the following winter. Again, reductions in air-borne bacteria were reported. In both of these studies the infants were continually in the TEG treated environment, but there were frequent contacts with nurses and physicians. Krugman and Ward concluded that cross infections were probably acquired by contact rather than through air-borne particles.

Few studies of the clinical effects of TEG vapor have been attempted in military barracks. Bigg et al. (10) installed TEG vaporizers in Hospital Corps School Barracks, Great Lakes, Ill., during the winter of 1943-1944 and observed the effect on admission rates for a variety of infectious diseases during three 6-week periods. During two 6-week periods, an average of 12 per cent fewer admissions occurred from the men living in the TEG-treated dormitories. Greater reductions were reported during the last 17 days of each 6-week period. Rates for the third period were not reported as TEG concentrations were thought inadequate. Bigg's study and the present study were conducted at the same station among young male military subjects, but the populations employed cannot be considered comparable.

Bigg et al. (1) also reported a later investigation at Chanute Field, Ill. A reduction in hospital admission rates from men living in TEG-treated barracks was again obtained but the study population was small and the study period short.

In evaluating the effects of prophylactic

agents on acute respiratory and other infectious diseases in military populations, it has been customary to measure the incidence of illness by a count of the number of visits and admissions to the medical facility. Differences in the numbers from test and control groups, have been expressed as "per cent reductions."

In the course of the present study it became apparent that in Navy recruits there was no constant relation between the number of men found to have respiratory infections at weekly examination of a company and the number who voluntarily sought treatment at the regimental infirmary from that company. Variations in this proportion were sometimes marked between different companies, particularly in the percentage of men who sought treatment with illnesses diagnosed as influenza or streptococcal infections. Since variations in the number of admissions did not reflect the amount of illness in a company, and were as marked between control companies as between test and control companies, admission rates cannot be considered as a valid index of the effect of a prophylactic agent in Navy recruits.

Methods aimed at the control of acute respiratory diseases in military personnel have been based upon the premise that a major pathway of spread of infections within the population is through air-borne particles and that the barrack is the site where the major spread occurs (12-15). The present study was based upon this hypothesis. It should be pointed out, however, that Navy recruits spend only about 60 per cent of their time in the barracks. Although much of the remaining time is spent out of doors, opportunities for contact spread within the company or from men of other companies exists when the men assemble in classrooms,

mess halls, regimental infirmaries, or recreational facilities. Air-borne infections are possible at these sites but it would not be feasible to install TEG vaporizers at all places of assembly. The variation in the magnitude of epidemics between companies suggests that the major pathway of spread was within the company, but the importance of the barracks as the site, and the role of air-borne particles and contact as pathways of spread, could not be determined. Major reductions in total air-borne bacteria should be effective in preventing respiratory infections if the spread is by the air-borne route. Despite a 65 per cent reduction in air-borne bacteria in the treated dormitories, beta hemolytic streptococci were easily recovered during bedmaking and sweeping, and a reservoir of organisms sufficient to transmit infections by inhalation may have remained.

The epidemiological behavior of acute respiratory diseases in companies of Navy recruits was of interest. Four apparently comparable companies of men are assigned to a barrack and follow similar training schedules, yet major variations in the incidence of certain respiratory diseases are found between the companies. If streptococcal infections are considered as indicative, this difference in the behavior is probably not due to the inclusion of differing numbers of infected men into the companies at the time of formation, but is a factor of varying magnitude of epidemic spread within the company after the introduction of the organism during training.

As exemplified by the experience of companies 13 through 16, the spread of beta hemolytic streptococcal infections usually occurs during the later weeks of training and the magnitude of spread of a given type of streptococcus may be

a factor of the relative time of its introduction into the company. Type 14 streptococci first appeared in the men of company 13 during the third week of training. The number of men with positive nose and throat cultures increased rapidly and coincided with an epidemic of type 14 streptococcal infections. This type was not recovered from the settling plates until after its appearance in nose and throat cultures. In contrast, type 14 streptococci did not appear in men of the other companies until later in training, and fewer men acquired positive nose and throat cultures or clinical infections. A further example in the differences in magnitude of spread of the same type was provided by two control companies 18 and 20. Type 18 streptococci appeared in company 18 during the fourth week but did not appear until later in company 20. By the time of the final examination, 35 per cent of the men in company 18 yielded a positive culture for this type, whereas only 16 per cent of company 20 were positive. Type 18 did not appear at any time either in the men or the environment of the companies in the TEG dormitories but its absence cannot be attributed to TEG, since the number of cultures for type 14 and other types increased in these companies during training and there was no evidence that type 18 had ever been introduced into the environment.

Companies were arbitrarily designated as "test" and "control" according to whether they lived in treated or untreated dormitories. Despite the apparent comparability of the "control" companies upon entry into training, the highly varied experience between them indicates that too many other factors operate, about which little is as yet known, to allow evaluation of the partial effectiveness of a prophylactic agent by

direct comparison between companies of Navy recruits. This cannot be relieved by the cumulation of companies into a larger population, although for the sake of comparison with results of others this was done and showed no appreciable differences between the number of infections in "test" and "control" populations. It was apparent from the results that TEG vapor was ineffectual in preventing the intracompany spread of acute respiratory diseases of either unknown or known etiology. Only 3 per cent of the men escaped respiratory infections despite TEG treatment of their dormitory.

Data derived from the use of dust suppressive measures, ultraviolet irradiation, and TEG vapor in the treatment of various environments indicate that, despite major reductions in air-borne bacteria, little effect has been obtained in the prevention of acute respiratory diseases. Although the problem cannot be solved until the reservoir of air-borne organisms can be completely eliminated, this evidence makes it difficult to be optimistic about the practical value of attempts to prevent respiratory diseases by the treatment of the environment. At least, until better adjunctive measures become available, there seems little reason to pursue the investigation of TEG vapor further as a control measure against acute respiratory diseases in military populations under the conditions of basic training.

SUMMARY

The effect of triethylene glycol vapor in Navy recruit dormitories on the incidence of acute respiratory diseases was studied in 1,322 men observed between September, 1950, and April, 1951. One half of these men lived in treated dormitories and the remainder lived at the

opposite end of the barracks and served as controls. The men were observed for the occurrence of respiratory infections at weekly examinations and at the regimental infirmary. Definitive diagnoses for respiratory diseases were supported by concurrent bacteriologic and serologic data.

Epidemics of influenza, streptococcal infections and other respiratory infections were not prevented in companies living in treated dormitories. While variation in the nature and extent of intracompany epidemics of acute respiratory diseases made direct comparisons between test and control companies precarious, there was no consistent reduction observed in test companies. The total number of infections was approximately equal in the test and control populations and only 3 per cent of the men in the test populations escaped infections. The behavior of acute respiratory diseases was apparently not modified by TEG vapor.

In Navy recruits, visit or admission rates to the regimental infirmary provided only a qualitative index of acute respiratory disease but failed to measure actual disease rates as determined by weekly examinations. Furthermore, between companies, the percentage of infected men who sought infirmary treatment varied considerably. Therefore, visit or admission rates were not considered a valid measure for the effect of the prophylactic agent.

CONCLUSION

Triethylene glycol vapor, under the conditions of its use in treating the dormitories housing Navy recruits, was ineffectual in the prevention of epidemics of influenza, streptococcal infections and other acute respiratory infections.

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