not found. The clinical picture was characterized by recurrent attacks of illness with transient lymphadenitis, lymphangitis, and swelling of the arms or thighs. Lymphangitis always spreads peripherally. There was no indication of the development of elephantiasis. Certain epidemiologic aspects of the incidence of the infection among troops are discussed. The vector is regarded as *Aëdes scutellaris*. Suggestions are given for the control of filariasis. The belief is expressed that early evacuation from the endemic region and avoidance of future exposure to further infection with the disease should minimize the danger of the development of permanent late lesions in these soldiers. Filariasis among natives of the island is briefly described. Of those examined by blood smear 40% had microfilariæ in their blood. At least 5% had elephantiasis.

7. SUMMARY OF A 3-YEAR STUDY OF THE CLINICAL APPLICATIONS OF THE DISINFECTION OF AIR BY GLYCOL VAPORS*

BY T. N. HARRIS, M.D.
AND
JOSEPH STOKES, JR., M.D.
PHILADELPHIA, PA.

(From the Children's Seashore House, Atlantic City, N. J., and the Department of Pediatrics, School of Medicine, University of Pennsylvania.)

THE clinical application of air disinfection by glycol vapors has been investigated for a period covering 3 winters at the Children's Seashore House in Atlantic City. A large part of this work has been reported previously in considerable detail.[1,2] These studies involved primarily the determination of the rate of incidence of respiratory infections in groups of patients whose air supply was largely disinfected, and in control groups.

This institution, a convalescent home, was selected because the prevailing conditions were peculiarly well adapted to the exhibition of the clinical effects of air disinfection. The patients were divided by age and sex into groups of 16, each of which occupied a ward. These wards were distributed on 2 floors of a building, the wards on the upper floor having the same size, position, exposure and window space, respectively, as those below them. The distribution of diagnoses did not vary markedly among the wards, so that the structure of the House provided pairs of wards, each well suited for control observations with respect to the other.

The patients were largely rheumatic or orthopedic, most of them bedfast, so that physical contact among patients was relatively small in extent. They were, however, not acutely ill, so that physical contact with nursing and attendant staff was not close. Accordingly, direct cross-infection or direct droplet hits were relatively less impor-

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tant in the transmission of respiratory pathogens, and droplet nuclei and infected dust more so. Some pairs of beds were contiguous, except during a respiratory episode affecting the occupant of such a bed, and toys and books were transferred at times, although infrequently, from bed to bed.

There was no contact among patients from different wards, since each of the classes held in the schoolroom for the small number of ambulatory patients was limited to patients from a single ward.

During the warmer part of every fair day, except very cold ones, all beds were wheeled to open porches adjoining the respective wards. For the remaining part of the 24 hours the beds were in the wards, and during that part of the day a minimum of outside air was admitted to the wards, in order to conserve heat. The operation of the vaporizing units was continuous.

Methods. Propylene glycol was used as the disinfecting agent during the preliminary observations of the winter of 1941–42 and the following year. In the past winter, 1943–1944, tri-ethylene glycol was used.

The method of vaporization was the same for both agents. The glycol was kept at a constant level in an insulated beaker, which was supplied from a reservoir. In the beaker was immersed an electrical resistance coil of whatever wattage-rating and resistance were necessary to vaporize the required amount of glycol per hour, when used directly on the house line of 110 volts. A small electric fan was placed before the vaporizer in order to pull the glycol vapor stream and disperse it into the air nearby.

The degree of disinfection of air was determined by settling plate counts, the results being expressed in colonies per Petri plate. Comparisons were made in experimental and control wards, the exposure period being 30 or 60 minutes, depending on the time of day.

Determinations of the concentration of glycol vapor in air were made according to the method of Puck[3] for propylene glycol, and the method of Wise, Puck and Stral[4] for tri-ethylene glycol.

The maintenance of adequate relative humidity was not found to constitute a problem, since readings in the wards at semi-weekly intervals ranged between 30 and 40%, usually above 35%.

Plan of Experiments. In planning the experiments, the wards of the Seashore House were divided into pairs, each pair consisting of wards similarly placed on the second and third floors. Glycol was vaporized alternately, first in one ward of the pair and then in the other during successive 3-week periods, the opposite member serving as a control. Three-day intervals were allowed between periods of observations for infections in a state of incubation. All observations, therefore, involve comparisons of two similarly placed wards at the same time, the wards differing only in that one contained glycol vapor in its atmosphere. A respiratory infection was defined as a clinically recognizable episode with some objective manifestation in addition to fever. Thus a sore throat was included only if it showed an inflamed nasopharynx on examination; a "common cold," or painful ear was included only if a discharge or evidence of inflammation was present, and a cough was included only if productive.

Observations were made of the rate of incidence of respiratory infections, bacterial settling plate counts, and concentration in air of the glycol vapor.

Results. *The Incidence of Respiratory Infections.* The rate of incidence of respiratory infections was markedly lower in wards containing the glycol vapor (Table 1).

The upper respiratory infections observed included coryza, tracheobronchitis, nasopharyngitis and otitis media. In the first and third

winters, there was no marked preponderance of any of these particular diseases. During the winter of 1942–43, however, coryza accounted for a majority of all observed infections. In view of the fact that the common cold is probably caused by a filterable virus or filterable viruses, while the other diseases observed are caused by bacteria, a finer analysis of the data for that year is given in Table 2.

TABLE 1.—THE RATE OF INCIDENCE OF RESPIRATORY INFECTIONS IN EXPERIMENTAL AND CONTROL WARDS

Winter	Glycol used	Ward-weeks	Respiratory infections	
			Experimental	Control
1941–42	Propylene	8	2	16
1942–43	Propylene	54	5	100
1943–44	Tri-ethylene	19	6	16*
		81	13	132

* The actual number of 26 infections in 31 ward-weeks has been reduced in proportion to 19 weeks for comparison with the 19 ward-weeks of observations in glycol-vaporized wards.

TABLE 2.—THE DISTRIBUTION OF RESPIRATORY INFECTIONS BY DIAGNOSIS (1942–43)

Disease	Number	
	Glycol	Control
Common cold	3	79
Tracheobronchitis, Otitis media, Pharyngitis, acute	2	21

The Bacterial Population in the Air. The relative reduction in the population of viable bacteria in the air as indicated by settling plates was greater and more constant in the course of vaporization of propylene glycol than tri-ethylene under the conditions of these experiments, probably because of the narrower range between bactericidal and condensing concentrations in the case of the latter. Because of this narrow range, it was difficult to maintain a minimum concentration of tri-ethylene glycol vapor in air as much above the effective bactericidal concentration as in the case of propylene glycol with the vaporizing devices used in this study. Average values of all determinations are shown in Table 3.

TABLE 3.—THE BACTERIAL SETTLING PLATE COUNTS IN EXPERIMENTAL AND CONTROL WARDS

Year	Glycol	Mean plate counts		
		Glycol	Control	Ratio control/glycol
1942–43	Propylene*	13.4	81.3	6.05
1943–44	Tri-ethylene	18.3	75.3	4.12
	Number of counts:	114	46	
	Standard error of mean:	0.9	2.2	

* Individual counts given in original report.[2]

The Concentration of Glycol Vapor. The concentration of propylene glycol vapor in air was maintained in the neighborhood of one part in 15,000,000 (0.069 mg./liter). Concentrations at various times and in

different parts of the experimental wards ranged from 0.048 mg./liter to 0.094 mg./liter.

In the case of tri-ethylene glycol the maintenance of a satisfactory concentration presented a greater problem, because of the narrow range between bactericidal concentration and precipitating concentration mentioned above. In the absence of sensitive methods for regulating or measuring concentrations of tri-ethylene glycol vapor in air, a rate of vaporization sufficient to disinfect the air to a considerable degree was often found to produce precipitation of glycol on windows, floors and objects in the ward. The concentration of this vapor in air ranged between 0.0018 mg./liter to 0.0033 mg./liter.

The vaporization of propylene and tri-ethylene glycol in bactericidal concentrations has in these experiments been shown to cause a reduction in the total incidence of respiratory infections.

Discussion.. The difficulties encountered in this study in the use of tri-ethylene glycol are due largely to the early stage of engineering development of the field and to the relatively small size of the enclosed spaces involved. In a larger volume of air, the fluctuations in glycol concentration caused by occasional opening of doors, etc., would be proportionately smaller and the concentration could be maintained in a narrower range. Because of the greater range of bactericidal concentrations of propylene glycol, it was technically the preferred glycol under the conditions of our experiments. The ultimate development of devices to regulate the rate of vaporization of tri-ethylene glycol by the concentration of the vapor present in air at the moment may obviate the difficulties we found in using this disinfectant and permit workers to take advantage of its higher disinfecting potency.

At the present writing, however, it would appear that for small spaces and in the absence of refined devices to regulate the rate of vaporization of glycol, propylene glycol is the agent of choice in small wards, offices and spaces of similar size.

In considering the application of these results to other situations, it is well to allow for the peculiarly favorable circumstances at the institution chosen for the experiments.

First, the generally inactive character of the institution and the absence of acutely ill children resulted in a considerably smaller extent of traffic into and out of the ward. Again, the patients were within the enclosed space of the ward only during the colder part of the day and at night. These factors not only reduced the total air exchange rate, but decreased the degree of fluctuations of concentration of glycol vapor in air.

The character of the patients also provided exceptionally favorable experimental conditions. Most of the children were bedfast, since the great majority were convalescing rheumatic and orthopedic patients. Of the latter, the majority were fixed in a supine position by casts, breast straps or extension weights. As a result, there was relatively much less direct contact or direct droplet hits than would be expected in a group of children, and correspondingly even a greater quantitative importance of droplet-nuclei in cross-infection. Again, in most of the

bedfast and all of the supine children, expulsion of infectious material and viable bacteria was largely in an upward direction, and the time of exposure to the glycol vapor was probably considerably longer, in general, than in other situations.

Finally, it is important that during the experimental periods in any ward, glycol vapor was present in the air supply of the subjects during all of the time spent indoors.

These favorable circumstances are, however, largely of quantitative significance. Under other conditions, a higher concentration of glycol in the air or controls on sudden shifts of masses of air into the ward or room might be necessary. The studies described here have demonstrated that the disinfection of air by glycol vapors can be successfully applied to the problem of prevention of air-borne cross-infection.

Summary. The disinfection of air by the vapor of propylene glycol and tri-ethylene glycol has been applied to the clinical problem of the transmission of air-borne cross-infection in a home for convalescent patients. A marked decrease was observed in the total rate of incidence of upper respiratory infections among those patients whose air-supply was largely disinfected by glycol vapor.

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8. EXPERIMENTAL AIR-BORNE TUBERCULOSIS*

BY MAX B. LURIE, M.D.
PHILADELPHIA, PA.

(From the Henry Phipps Institute, University of Pennsylvania)

Air-borne Contagion of Tuberculosis in an Animal Room. If normal guinea pigs[1] are placed in individual cages in a room housing tuberculous animals, the exposed pigs acquire tuberculosis of respiratory origin as evidenced by pulmonary lesions, massive tuberculous involvement of the tracheobronchial nodes draining the pulmonary portal of entry and the absence of any disease in the mesenteric or cervical nodes draining the alimentary portal. As is well known, tuberculosis characteristically leaves the traces of its progression in the body by the involvement of the nodes draining the portal of entry.

As may be seen in Figure 1, guinea pigs situated at a considerable distance from their tuberculous room-mates acquire tuberculosis just as often as the guinea pigs placed in immediate proximity to tuberculous animals. Therefore, we may assume that the contagion is uniformly distributed in the room and, since the disease is respiratory in origin, the contagion is air-borne.

Method of Studying Air-borne Contagion of Tuberculosis in Inbred Rabbits of Varying Resistance to the Disease. A large manifold[2] is

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