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AIR STERILIZATION IN AN INFANTS' WARD

EFFECT OF TRIETHYLENE GLYCOL VAPOR AND DUST-SUPPRESSIVE MEASURES ON THE RESPIRATORY CROSS INFECTION RATE

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The control of respiratory cross infections in infants' wards has always presented a serious problem.[1] Since the introduction of gamma globulin, sulfonamides and antibiotics this problem has become less acute. Nevertheless, there are still far too many respiratory tract infections—bacterial, viral and of unknown cause—which are acquired after admission to a hospital ward.

The relative importance of contact versus air-borne infection has not been established. However, in recent years the air-borne mode of transmission has received much emphasis.[2] The study to be described is concerned with two measures for the control of air-borne infection—use of triethylene glycol vapor and dust suppression by oiling.

Triethylene glycol vapor possesses marked bactericidal and virucidal properties against a variety of air-borne micro-organisms. Robertson and his associates [3] demonstrated that it was rapidly lethal for hemolytic streptococci, pneumococci, staphylococci, influenza bacilli and the PR8 strain of influenza virus. Rosebury and his associates [4] showed that meningopneumonitis and psittacosis viruses were also susceptible to the action of this vapor. Recently in our laboratory we found that triethylene glycol vapor was similarly effective against air-borne mumps virus and Newcastle disease virus,[5] as well as Hemophilus pertussis and one of the saprophytic acid-fast bacilli, the smegma bacillus (Mycobacterium smegmatis).[6] The optimum conditions for the effective action of triethylene glycol vapor are a temperature of 70 to 80 F., a relative humidity between 20 and 50 per cent and a vapor saturation of more than 50 per cent. Moist bacterial particles are extremely susceptible to the action of the vapor; on the other hand, naturally occurring dried dust-borne bacteria are relatively resistant.

Dust can be a fertile reservoir of many pathogenic micro-organisms, which are the etiologic agents of certain respiratory tract diseases. These infections may be acquired by inhaling dust-borne organisms rendered air-borne by the acts of sweeping and bed making. The use of a triton NE® oil emulsion for the mopping of floors and the treatment of linens in hospital wards has been an effective practical method for reducing the dust-borne bacterial count of the air.[7]

The present investigation was undertaken to determine whether triethylene glycol vapor and oiling would effectively reduce the respiratory cross infection rate of an infants' ward. It was conducted in two identical wards—test and control. During the first part of the study, from February to May 1949, triethylene glycol vapor in the test ward was the only agent introduced. No dust-suppressive measures were used during this period. During the second part of the study, from December 1949 to May 1950, both triethylene glycol vapor and dust-suppressive measures were employed.

MATERIALS AND METHODS

Wards.—The ward originally was 90 feet long, 30 feet wide and 13½ feet high. It was converted into a test ward, a control ward and a nurses' anteroom by erecting vapor-tight partitions. Two large plate glass observation windows were installed in the anteroom partition, so that each entire ward could be observed by a nurse from her desk outside. Separate and identical mechanical ventilating systems were provided for each

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The medical house staff and the nursing staff of the Children's Medical Service, Bellevue Hospital, cooperated in this study. Mrs. Olga Mossbacher and Mrs. Bertha Swerdlow gave technical assistance. Mr. Stanley S. Rosavage, foreman in charge, Bellevue Hospital Laundry, helped in the oiling procedures. The Air Purification Service, Inc., gave technical advice and maintained the glycol vaporizer.

1. McKhann, C. F.; Steeger, A., and Long, A. P.: Hospital Infections: I. A Survey of the Problem, Am. J. Dis. Child. **55**: 579-599 (March) 1938.

2. Buchbinder, L.: The Transmission of Certain Infections of Respiratory Origin: A Critical Review, J. A. M. A. **118**: 718-730 (Feb. 28) 1942. Robertson, O. H.; Hamburger, M., Jr.; Loosli, C. G.; Puck, T. T.; Lemon, H. M., and Wise, H.: A Study of the Nature and Control of Air-Borne Infection in Army Camps, ibid. **126**: 993-999 (Dec. 16) 1944.

3. Robertson, O. H.; Puck, T. T.; Lemon, H. M. and Loosli, C. G.: The Lethal Effect of Triethylene Glycol Vapor on Air-Borne Bacteria and Influenza Virus, Science **97**: 142-144, 1943. Robertson, O. H.: Sterilization of Air with Glycol Vapors, in Harvey Lectures, 1942-43, Baltimore, Williams & Wilkins Company, 1943, p. 227.

4. Rosebury, T.; Meiklejohn, G.; Kingsland, L. C., and Boldt, M. H.: Disinfection of Clouds of Meningopneumonitis and Psittacosis Viruses with Triethylene Glycol Vapor, J. Exper. Med. **85**: 65-76, 1947.

5. Krugman, S., and Swerdlow, B.: Lethal Effect of Triethylene Glycol Vapor on Air-Borne Mumps Virus and Newcastle Disease Virus, Proc. Soc. Exper. Biol. & Med. **71**: 680-684, 1949.

6. Krugman, S., and Winter, J. E.: Unpublished data.

7. Loosli, C. G.: Dust and Its Control as a Means of Disinfection of Air, Am. J. Pub. Health **37**: 353-359, 1947.

ward. Each system drew in 600 cubic feet of outdoor air per minute, filtered it through glass wool fiber screens and heated it under thermostatic control to room temperature. This air was then discharged through small grilles spaced 8 feet apart in a 10 inch square duct extending the length of the ward along the ceiling at the outer wall margin. There were three air changes per hour in each ward, the air leaving via two escape louvres located above the windows in the outer wall. Each

TABLE 1.—*Age and Period of Hospitalization of Patients in Control and Test Wards*

	1949		1950	
	Control	Test	Control	Test
Total admissions	72	58	63	52
Total patient-hospital days	2,150	2,020	2,011	2,125
Mean no. of days per patient	30	35	32	41
Mean age (months) on admission	7.5	9.5	5.8	5.3
% less than 6 months	54	46	65	65
% 6 to 12 months	26	23	14	19
% 12 to 18 months	13	14	8	8
% 18 to 24 months	7	17	13	8

ventilating system was provided with means for introducing steam directly into the air stream to maintain a constant relative humidity in response to a humidistat located 5 feet from the floor on the center partition at the midpoint of the ward. A Taylor instrument located adjacent to the humidistat maintained a continuous graphic record of the temperature and relative humidity. A fairly constant temperature of 78 F. and a relative humidity of approximately 43 per cent was maintained throughout the study.

The Glycol Vaporizer.—A glycol vaporizer [8] was attached to the test ward ventilating system. This was installed so as to introduce a controlled amount of triethylene glycol vapor directly into the ventilating air stream at a point between the heating coil and fan. In passing through the fan, the glycol-laden air was thoroughly mixed with the ventilating air and uniformly distributed throughout the test ward. Approximately 20 cubic feet of air per minute was drawn into the vaporizer, where it was warmed to the desired temperature by electric cartridge heaters controlled by a thermostat within the unit. The heated air then passed over a multiplicity of woven, spun glass wicks saturated with triethylene glycol fed by capillary action from a 5 gallon storage sump in the base of the vaporizer. Thus, a definite amount of glycol was evaporated from the wick section into the ventilating air stream.

Control of Glycol Concentration.—With the vaporizer set at 162 F. a faint fog was apparent in the test ward at all times. This assured the maintenance of an adequate concentration

TABLE 2.—*Bacterial Content of Air*

	1949		1950	
	Control Ward	Test Ward *	Control Ward	Test Ward †
No. of days on which air samples were taken	13	13	25	25
Mean no. of patients	19	19	15	16
Mean relative humidity	43.4	43.2	45.3	45.0
Mean no. of bacteria per 1 hour settling plate	170	152	126	43
Mean no. of bacteria per cubic foot of air	52	30	68	9

* Triethylene glycol vapor only.
† Triethylene glycol vapor plus dust-suppressive measures.

of triethylene glycol vapor throughout the entire study. At periodic intervals equal quantities of a culture of group C hemolytic streptococci were sprayed into each ward. The organisms could not be recovered on blood agar settling plates one minute after cessation of spray in the glycolized ward. In the control ward, however, they persisted for at least 15 minutes. In this way it was demonstrated that a bactericidal concentration of glycol was present in the air.

Dust-Suppressive Measures.—During the second part of the study the floor of the test ward was mopped daily with T-13 oil emulsion (triton NE® 13 per cent, liquid petrolatum 87 per cent), 1 part to 10 parts of water. All test linens, blankets, gowns and miscellaneous wearing apparel were treated with the same oil emulsion in the manner described by Puck, Robertson, Wise, Loosli and Lemon.[9]

Bacteriological Procedures.—Nasopharyngeal Cultures: Materials for culture were obtained from all patients on admission, routinely each week and at the onset of a respiratory infection. Ward personnel had cultures weekly. The following method was used: A copper wire swab was inserted through each nostril into the nasopharynx. It was removed after 15 seconds, then smeared on a blood (5 per cent horse blood) agar plate and finally inserted into a tube containing 5 cc. of 2 per cent blood broth. After 18 hours of incubation at 37 C. the plates were examined for hemolytic streptococci, pneumococci and other pathogens. Streptococci were transferred to neopeptone infusion broth for subsequent grouping and typing. Pneumococci were typed directly from the broth cultures. Colonies of H. influenza were subcultured onto chocolate agar for further identification and typing.

Air Samples: The air of both wards was sampled each week by the settling plate and Folin bubbler sampler methods. This was done in the morning between 8:00 and 9:00 o'clock, during

TABLE 3.—*Incidence of Cross Infections During 1949*

	Control Ward		Test Ward	
	No.	Rate *	No.	Rate *
I. Clinical infections (total)	31	14.4	10	4.95
A. Respiratory infections	24	11.1	10	4.95
B. Measles and chickenpox	7	3.3	0	0
II. Carriers of pneumococci acquired in ward	15	6.9	14	6.9

* Rate per 1,000 patient-hospital days.

the period of maximum activity, such as bedmaking, bathing and feeding of infants. Three blood agar plates were exposed for one hour—one in the center and one at each end of the ward. After incubation for 18 hours at 37 C. the total number of colonies was counted and pathogens, if present, were identified.

Plan of Study.—Patients between 1 day and 2 years of age were admitted to each ward, which had a capacity of 20 cribs. The population consisted chiefly of boarders and a few convalescent infants transferred from a ward for acute disease. When a cross infection developed it was recorded and promptly treated. Patients who contracted contagious diseases, such as measles and varicella, were removed from the ward after the diagnosis was established.

The following criteria for the diagnosis of a clinical respiratory cross infection were used: fever, irritability and vomiting plus one or more of the following signs and symptoms occurring five or more days after admission to the ward—coryza, cough, red throat, red tympanic membranes, draining ear, hoarseness or other respiratory tract manifestations. In case of a disease with a known incubation period, such as measles, the five day limit was extended to 10 or 11 days. We recorded all patients showing no clinical evidence of disease in whom nasopharyngeal cultures revealed a new pathogenic microorganism not previously isolated during weekly culture.

The technic for handling the patients was identical in the two wards. Owing to the shortage of nurses and attendants, aseptic technic was frequently broken. Thus, there was ample opportunity for indirect contact between patients. However, this situation prevailed in both wards. On the other hand, the factor of direct contact was reduced to a minimum because for the most part all the infants were kept constantly in their cribs, which were spaced four to five feet apart.

During the 1949 study, when only triethylene glycol vapor was used, there were 72 new patients admitted to the control

8. Model ARA-4, manufactured by Air Purification Service, Inc., Newark, N. J.

9. Puck, T. T.; Robertson, O. H.; Wise, H.; Loosli, C. G., and Lemon, H. M.: The Oil Treatment of Bedclothes for the Control of Dust-Borne Infection, Am. J. Hyg. **43**: 91-104, 1946. Loosli, C. G.; Wise, H.; Lemon, H. M.; Puck, T. T., and Robertson, O. H.: The Oil Treatment of Bedclothes for the Control of Dust-Borne Infection, II, ibid. **43**: 105-119, 1946.

ward and 58 to the test ward. During 1950, when both triethylene glycol vapor and dust-suppressive measures were employed, there were 63 new patients admitted to the control ward and 52 to the test ward. The age and period of hospitalization during both periods were comparable in both wards, as indicated in table 1.

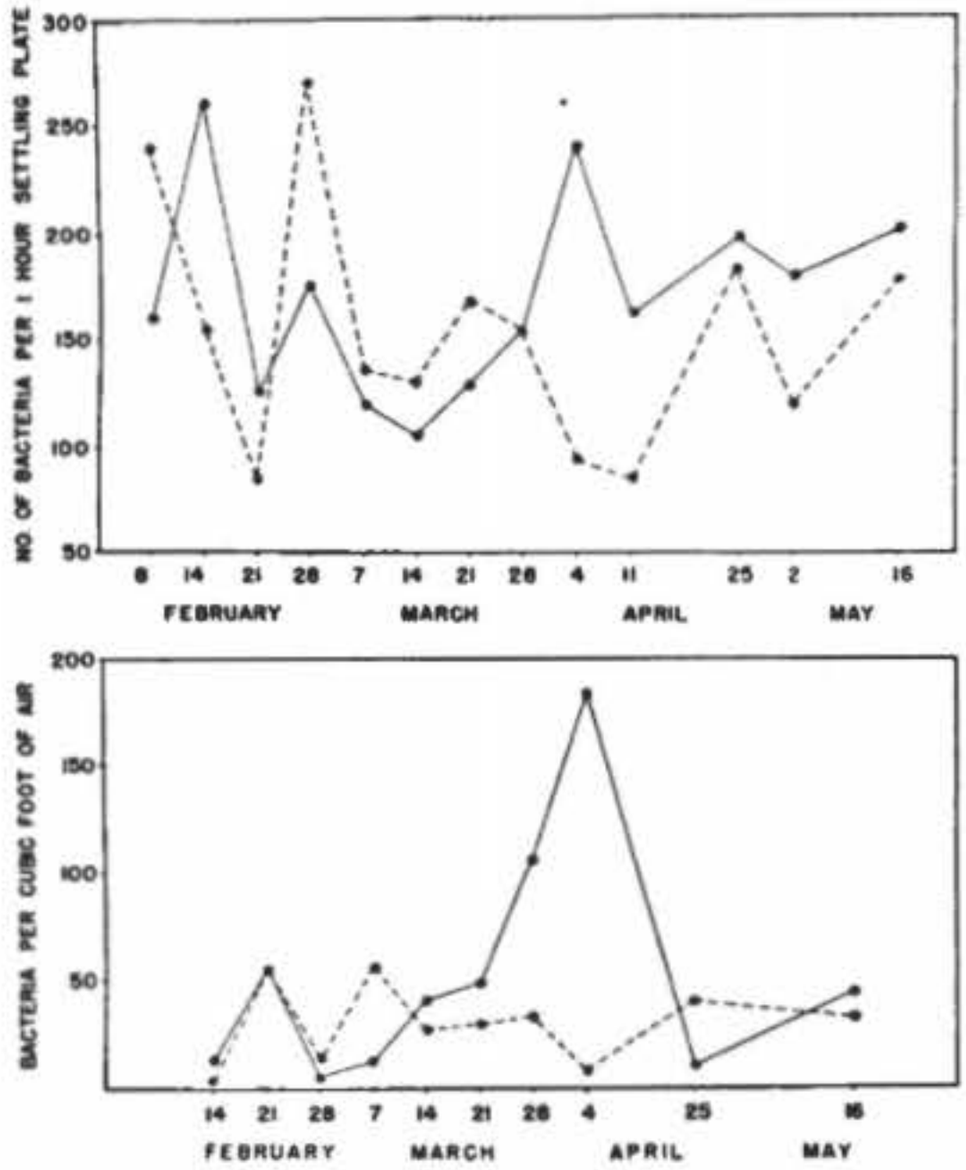

Chart. 1.—Effect of triethylene glycol vapor on air-borne bacterial count as determined by settling plate samples (upper figure) and air bubbler samples (lower figure). In each figure the unbroken line indicates values for the control ward; the broken line, the test ward.

RESULTS

Air-Borne Bacterial Count.—In table 2 is shown a comparison of certain environmental conditions obtaining in the two wards, including the bacterial content of the air. During 1949, when only triethylene glycol vapor was used, the mean number of bacteria recovered from settling plates was 152 in the test ward and 170 in the control ward, a reduction of 11 per cent. On the basis of air bubbler samples, the mean number of bacteria per cubic foot of air was 30 in the test ward as compared with 52 in the control ward, a reduction of 40 per cent. The weekly bacterial counts are graphically illustrated in chart 1. It is apparent that there was no consistent difference in the bacterial content of the air of each ward over an extended period.

There was a striking reduction in the air-borne bacterial count of the test ward when dust-suppressive measures were used in addition to triethylene glycol vapor, during the 1950 study. The mean number of bacteria recovered from settling plates was 43 in the test ward as compared with 126 in the control ward—a reduction of 66 per cent. On the basis of air bubbler samples, the mean number of bacteria per cubic foot of air was 9 on the test ward as compared with 68 on the control ward, a reduction of 87 per cent. This significant reduction in the bacterial content of the air of the test ward is graphically shown in chart 2.

During the 1950 study approximately 50 per cent of the patients in each ward had positive nasopharyngeal cultures for type 14 Pneumococcus. It can be seen in chart 2 that this micro-organism was not eliminated from the air of the test ward, where it was recovered on 11 separate occasions as compared with 10 in the control ward.

Cross Infections, 1949 Study.—In table 3 the incidence of respiratory cross infections during the 1949 study in the test ward is compared with that in the control ward. These included acute nasopharyngitis, acute otitis media, pneumonia, measles and chickenpox. A total of 31 cross infections developed on the control ward, as compared with 10 in the test ward. The rates per 1,000 patient-hospital days were 14.4 and 4.95 respectively.

Of the 31 cross infections in the control ward, six represented the second or third infection in the same patient. In the test ward there was only one patient who had more than one cross infection.

During the course of the study patients were unwittingly admitted to both wards while incubating measles or varicella. Table 4 lists the results of the exposures to measles. On February 4, a patient with a rash of

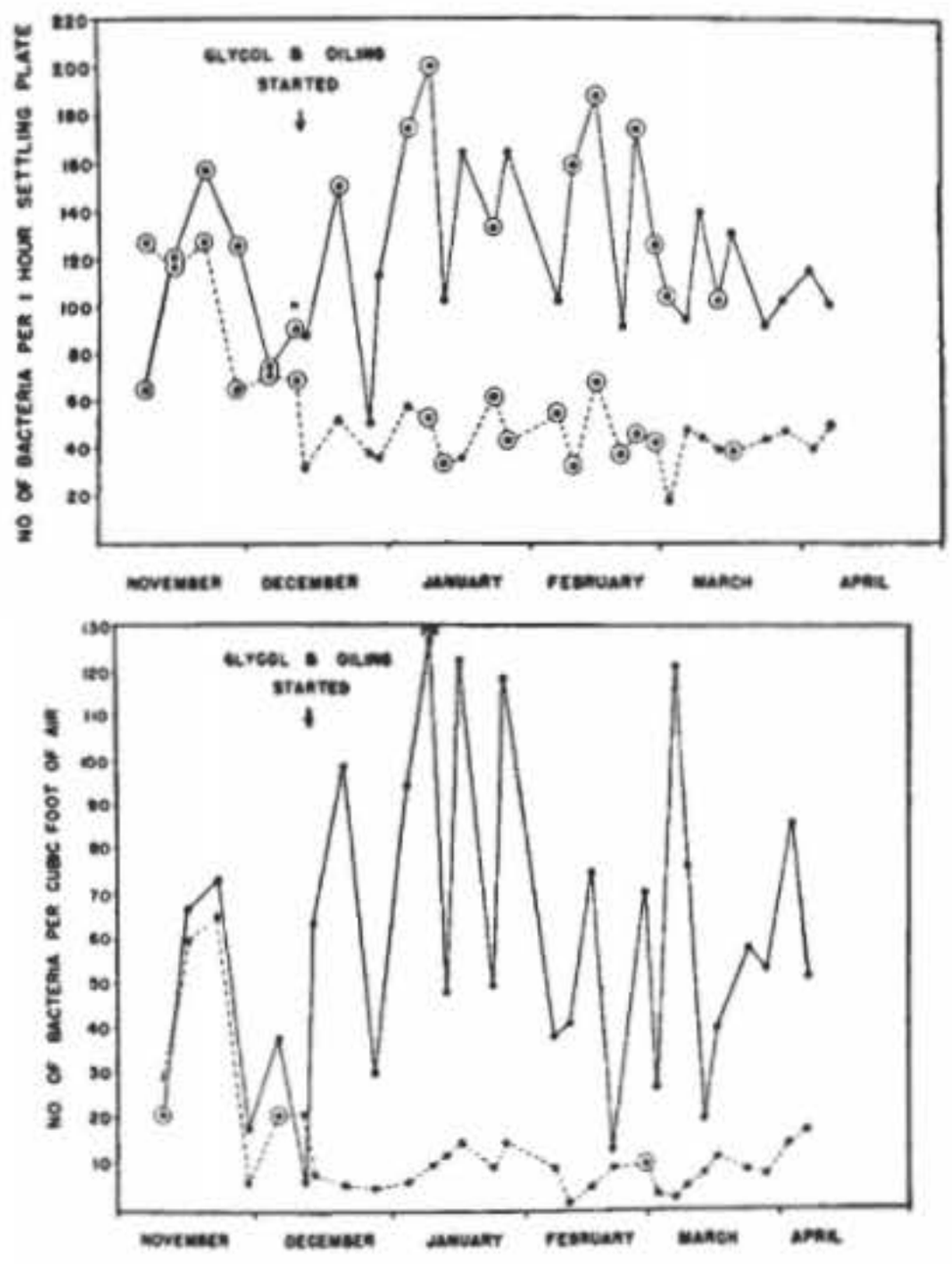

Chart 2.—Effect of triethylene glycol vapor and oiling on air-borne bacterial count as determined by settling plate samples (upper figure) and air bubbler samples (lower figure). The unbroken line indicates values for the control ward; the broken line, values for the test ward; the large circles, isolation of Pneumococcus type 14 on culture.

24 hours' duration spent eight hours in the test ward and the control ward before a diagnosis of measles was established. As indicated in chart 3 the number of presumably susceptible patients ranging in age from 6 months to 2 years was 11 in the control ward and

eight in the test ward. No cross infections resulted in the test ward. Measles developed in one patient in the control ward after an incubation period of 10 days. This patient was 10½ months old, and his crib was approximately 35 feet away from the original case.

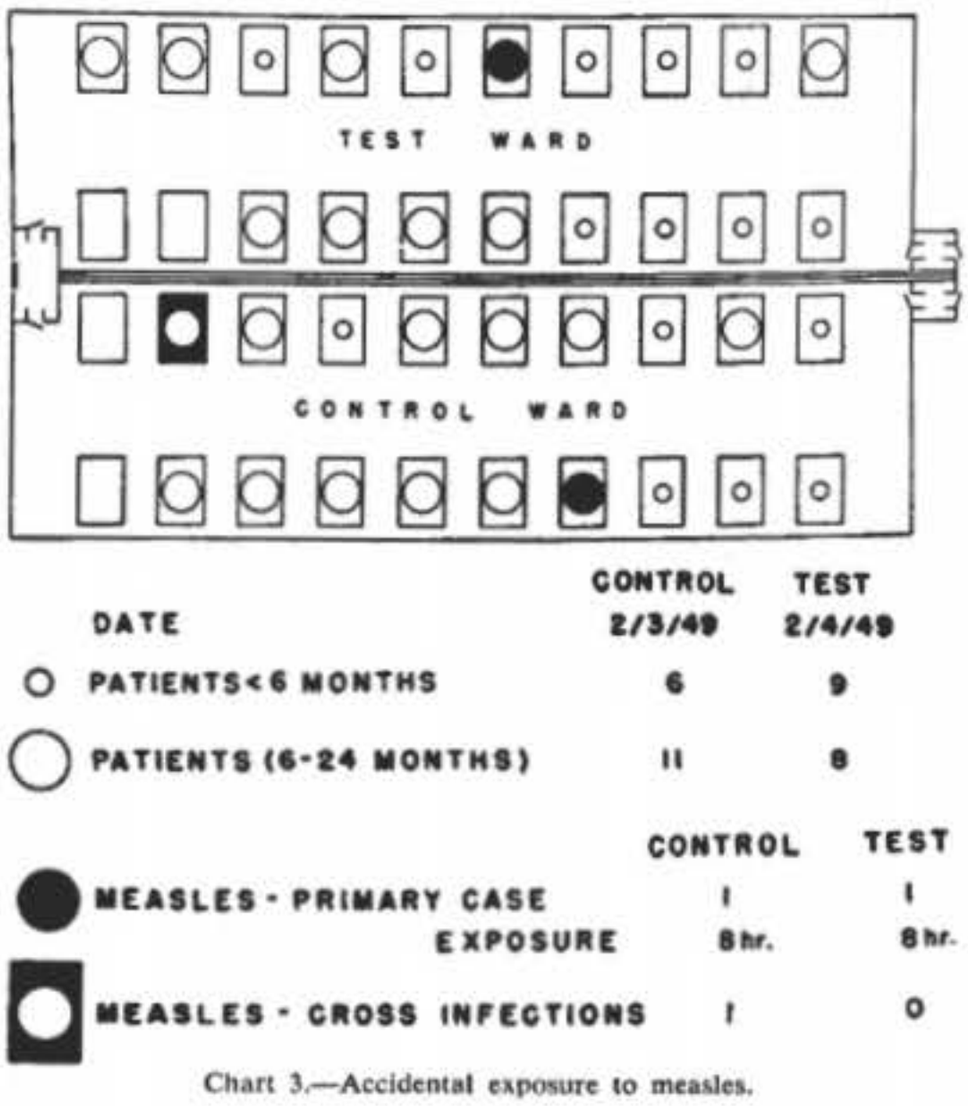

Chart 3.—Accidental exposure to measles.

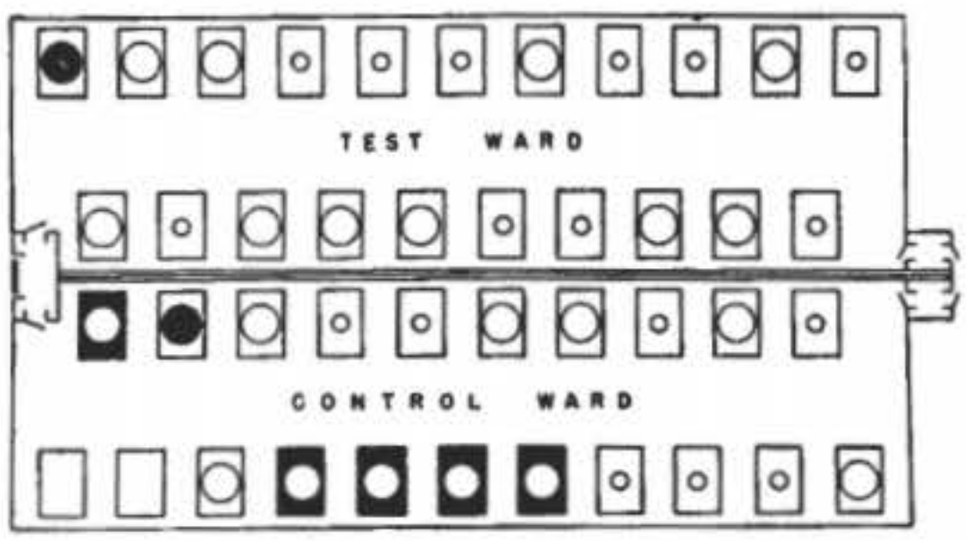

Chart 4.—Accidental exposure to measles.

The diagnosis of measles in this secondary case in the control ward was not established until February 16, two days (48 hours) after the onset of the disease. As shown in chart 4, there were 11 presumably susceptible patients in this ward; of these, eight had been previously exposed on February 4. Five cases of measles resulted, after the appropriate incubation period, in patients ranging in age from 8 months to 2 years. The recipients were separated from the donor by distances varying between 5 and 25 feet. Subsequently, on March 2 and on May 8, the test ward was reexposed to measles for periods of 30 and 48 hours respectively. In both instances primarily infected patients showed Koplik spots but no exanthem. The typical rash of measles subsequently appeared after the patients were transferred to another hospital. No cross infections resulted from either exposure.

The results of the varicella exposure are listed in table 5. On April 20, 1949, 10 presumably susceptible patients from 6 months to 2 years of age on the control

TABLE 4.—*Result of Accidental Exposure to Measles*

Ward	Date of Exposure	No. of Patients Exposed *	Hours of Exposure	Number of Cross Infections
Control.....	2/ 4/49	11	8	1
	2/16/49	11 †	48	5
Test.....	2/ 4/49	8	8	0
	3/ 2/49	10	30	0
	5/ 8/49	11	48	0

* Presumably susceptible patients over 6 months of age.
† Eight of the 11 patients were exposed on 2/4/49.

TABLE 5.—*Result of Accidental Exposure to Varicella*

Ward	Date	No. of Patients Exposed *	Hours of Exposure	Number of Cross Infections
Control.....	4/20/49	10	8	1
	5/ 5/49	12	24	0
Test.....	5/ 8/49	12	24	0

* Presumably susceptible patients over 6 months of age.

TABLE 6.—*Incidence of Cross Infections During 1950*

	Control Ward		Test Ward	
	No.	Rate *	No.	Rate *
I. Clinical infections (total).....	13	6.5	20	9.4
A. Respiratory infections.....	13	6.5	19	8.9
B. Measles	0	0	1	0.5
II. Carriers of pneumococci acquired in ward.....	7	3.5	9	4.2

* Rate per 1,000 patient-hospital days.

ward were exposed for eight hours to a patient with varicella in the first day of rash. One cross infection resulted on May 5, in a 19 month old boy who was in a crib 6 feet away. There were 12 presumably susceptible patients exposed to this secondarily infected patient for 24 hours during the first day rash, with no resulting cross infections. On May 8, 12 presumably susceptible patients on the test ward had a similar exposure for 24 hours during the first day rash. No cross infections resulted from this exposure.

As indicated in table 3 the rate per 1,000 patient-hospital days for carriers of pneumococci acquired in the ward was 6.9 for both wards.

Cross Infections, 1950 Study.—Table 6 compares the incidence of respiratory cross infections in the two wards during the 1950 study. There were 13 cross infections in the control ward as compared with 20 on the test ward. The rate per 1,000 patient-hospital days was 6.5 and 9.4 respectively. The number of multiple cross infections in the same patient was equal in the two wards.

There was only one experience with measles during this period. Each ward was exposed to patients in the prerash stage of the disease (chart 6). The number of presumably susceptible patients over 6 months of age was six in the control ward and eight in the test ward. There were no cross infections in the control ward. In the test ward one patient in a crib adjacent to the donor acquired measles. This secondarily exposed patient reexposed 7 presumably susceptible patients in the ward for 48 hours in the prerash stage. No cross infections resulted.

As indicated in table 6, the rate per 1,000 patient-hospital days for carriers of pneumococci acquired in the ward was 3.5 for the control ward and 4.2 for the test ward.

Cross Infections, Combined Study Period.—The total number of respiratory cross infections for the combined 1949-1950 period was 44 in the control ward and 30 in

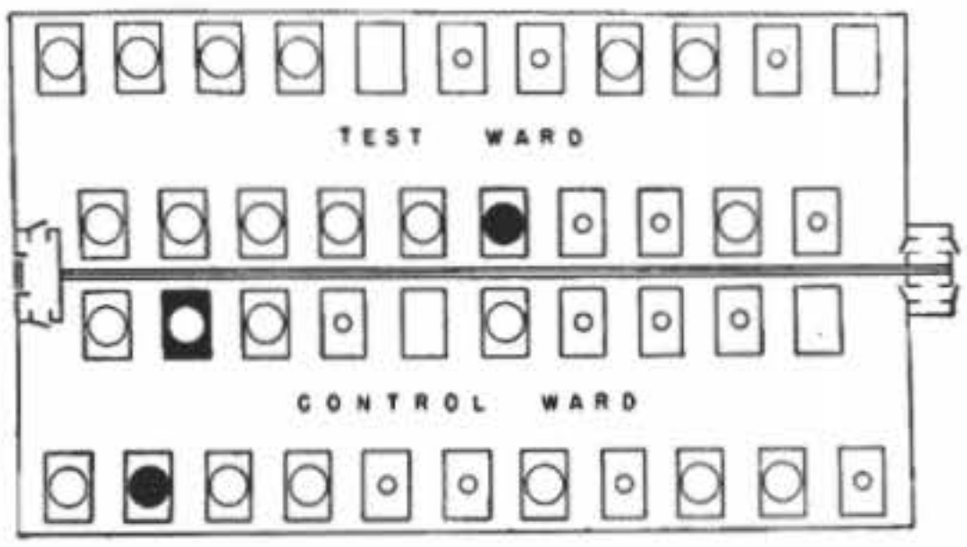

Chart 5.—Accidental exposure to varicella.

the test ward. As indicated in chart 7 the rate per 1,000 patient-hospital days was 10.4 for the control ward and 7.2 for the test ward.

COMMENT

During the 1949 study the cross infection rate in the glycol ward was significantly lower than that in the control ward. In 1950, however, the glycol ward had a slightly higher rate. These parodoxical results can possibly be explained by at least two factors.

First, there was the factor of multiple cross infections in the same patient. In 1949 there were six patients in the control ward in whom at least two infections developed; in contrast, there was only one such patient in the test ward. This would suggest that the control ward had a more susceptible population during this period. In 1950 the distribution of patients in whom multiple cross infections developed was the same in the two wards.

The second factor was the outbreak of secondary measles cases in 1949. Six of the 31 cross infections in the control ward were cases of measles. The experience in 1950 was different in that only one case of measles appeared, and this one developed in the glycol ward.

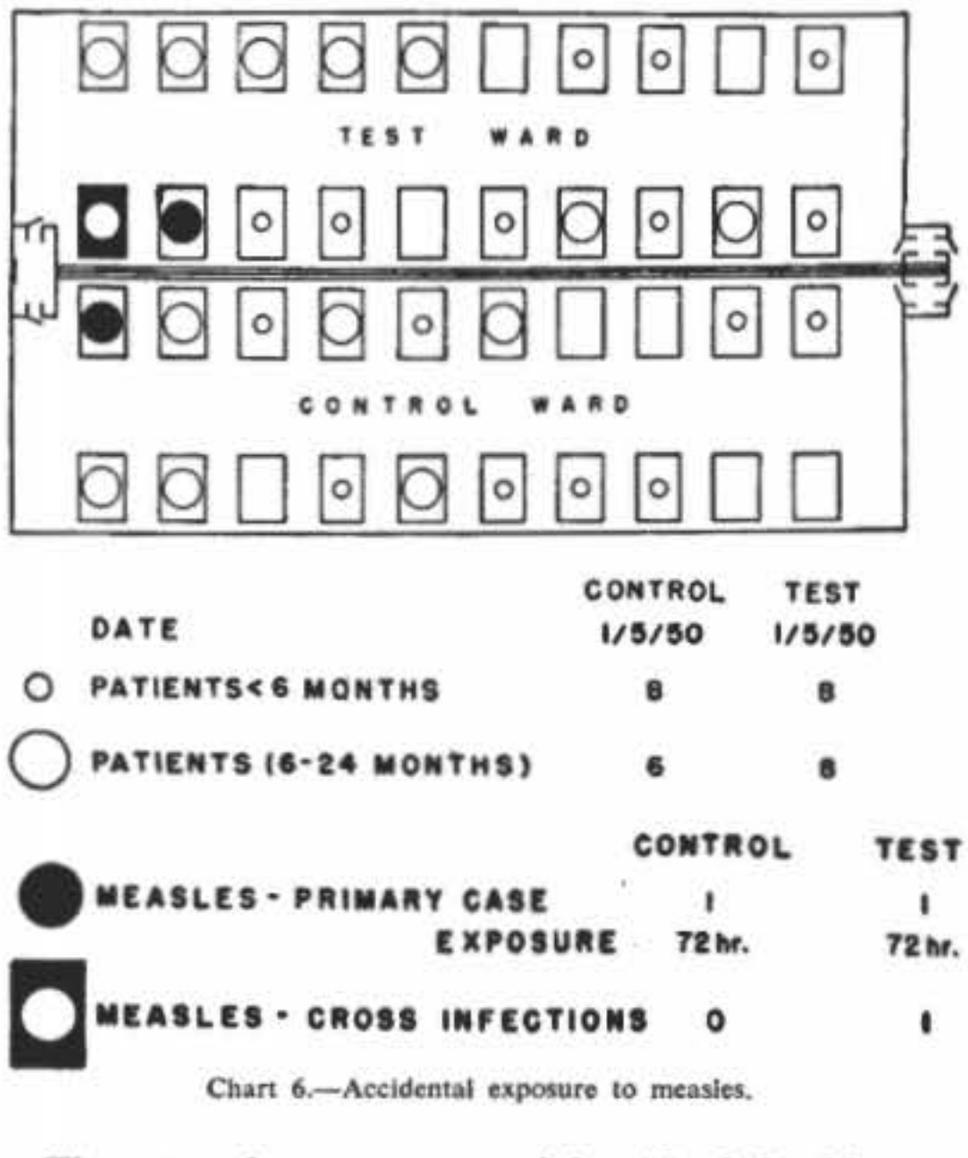

Chart 6.—Accidental exposure to measles.

These two factors accounted for 13 of the 31 cross infections in the control ward in 1949. If this number is subtracted from the total of 31, then the resulting difference between the cross infection rates of the two wards might have occurred by chance alone. It is of interest, also, that the elimination of the 13 cross infections from the total of 44 in the control ward for the combined study period would give an identical rate per 1,000 patient-hospital days of 7.2 for each ward.

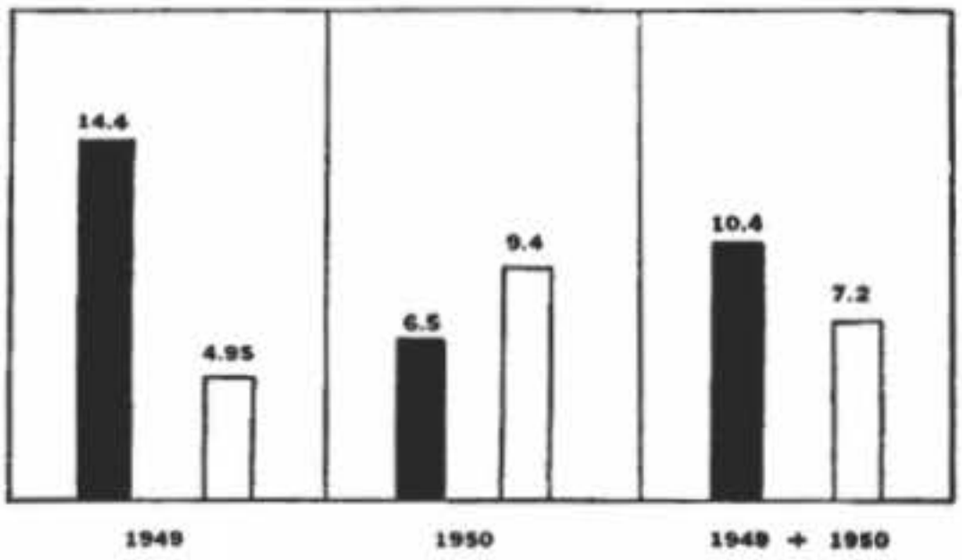

Chart 7.—Cross infection rate per 1,000 patient-hospital days in the control ward (black blocks) and in the test ward (white blocks).

Loosli and his associates [10] conducted a similar study in the infants' wards of the Harriet Lane Home, Johns Hopkins Hospital. Their observations, based on approx-

10. Loosli, C. G.; Smith, M. H. D.; Gauld, R. L.; Robertson, O. H., Puck, T. T.: Control of Cross-Infections in Infants' Wards by the Use of Triethylene Glycol Vapor, Am. J. Pub. Health 37: 1385-1398, 1947.

imately 2,300 patient-hospital days, revealed a lower incidence of cross infections in the glycol ward than in the control ward, but the difference was not statistically significant.

In our study triethylene glycol vapor and triethylene glycol vapor plus oiling had no effect on the carrier rate. Loosli,[10] who recorded these as inapparent infections, also found no difference in the incidence of carriers in the two wards.

The experience with measles was very suggestive. There was only one cross infection in the glycol ward following four separate periods of adequate exposure. In the control ward there was a total of six cross infections following three separate exposure periods. During a previous study [11] there were two patients who failed to contract measles after exposure in the glycol ward. Subsequently, they were reexposed in the control ward and came down with the disease after the appropriate incubation period. The favorable result in the test ward could conceivably be due to the virucidal action of triethylene glycol vapor. However, more experiences indicating that these results are reproducible are required before one can arrive at any definitive conclusion.

The failure of triethylene glycol vapor to effect a consistent significant reduction in the cross infection rate could have been due to at least two factors: Either triethylene glycol vapor was not an effective air-sterilizing agent under natural ward conditions, or the mode of spread of the infections was chiefly by contact rather than by the air-borne route. During the 1949 study the glycolized air of the test ward was rapidly lethal for group C hemolytic streptococci that were atomized into the air. On the other hand, it was relatively ineffective against the bacterial content of the air as determined by samples taken during the morning hours of maximum activity (chart 1). This apparent discrepancy reemphasizes a known deficiency of triethylene glycol vapor—namely, its failure to act as efficiently against dried dust-borne bacteria [12] as it does against moist bacterial particles. It was for this reason that oiling was added to the glycol vapor in the 1950 study.

The introduction of dust-suppressive measures caused a significant and consistent reduction in the bacterial content of the air of the test ward (fig. 2), but it had no effect on the cross infection rate (table 6). To us this suggests that contact infection was probably responsible for most of the cross infections and that the air-borne mode of transmission played a very small part. Under conditions such as these, even the most ideal air-sterilizing agent would probably have been ineffective.

The value of an air sterilizing agent for the ward, the factory or the home will depend on the relative importance of air-borne versus contact infection in the particular situation. If triethylene glycol vapor proves to be ineffective, perhaps other air sterilizing agents should be subjected to further investigation. Lovelock [13] has shown that lactic acid and α-hydroxy-α methyl-butyric acid possess the property of destroying dry dust-borne bacteria in the normal relative humidity range.

The paradoxical results obtained in the two study periods can best be resolved by accumulating more data.

SUMMARY

A study was conducted on two identical infants' wards, one with and the other without triethylene glycol vapor. During the first part of the investigation in 1949 only triethylene glycol vapor was used in the test ward. The results indicated that the cross infection rate in the glycol ward was significantly lower than that in the control ward.

During the second part of the study, in 1950, dust-suppressive measures were instituted in the test ward in addition to the triethylene glycol vapor. This included the daily mopping of floors and the treatment of all linens with T-13 oil emulsion. The results of this part of the study showed that the cross infection rate in the glycol ward was slightly higher than that in the control ward.

The value of an air-sterilizing agent for a ward depends on the relative importance of contact versus air-borne infection. During the present study contact infection seemed to be responsible for most of the cross infections.

ADDENDUM

Since this paper was submitted for publication, we have made additional observations based on 1285 patient-hospital days in each ward. In the test ward both triethylene glycol vapor and boiling procedures were used. There were twelve cross infections in the test ward and eleven in the control.

11. Krugman, S., and Ward, R.: Unpublished data.

12. Puck, T. T.; Robertson, O. H., and Lemon, H. M.: The Bactericidal Action of Propylene Glycol Vapor on Microorganisms Suspended in Air, J. Exper. Med. 78: 387-406, 1943.

13. Lovelock, J. E.: Aliphatic α-Hydrocarboxylic Acids as Air Disinfectants: Studies in Air Hygiene, Medical Research Council Special Report Series, no. 262, London, His Majesty's Stationery Office, 1948.

The Patent Ductus Arteriosis.—When a ductus arteriosus remains open beyond the neonatal period, the individual has a shunt which is similar to an arteriovenous fistula. Such a communication may be tolerated extremely well if the possessor is fortunate enough to escape superimposed infection and if the shunt is a small one. Under such circumstances humans have had little or no incapacitation, and indeed have lived to advanced age. Unfortunately, such a favorable outcome is not encountered in a high percentage of cases; there are certain hazards which occur rather frequently: (1) The shunt may divert so much blood from the aorta that the peripheral circulation is robbed and the individual has a retarded physical development. (2) The heart may increase its output, attempting to maintain the peripheral flow at a satisfactory level; while accomplishing this an exceedingly large amount of blood is passed back through the ductus. The individual may be well developed, and indeed be entirely normal in appearance, but the heart will come to embarrassment or failure. (3) Bacterial infection may be superimposed upon the vascular abnormality, the causative organism commonly being the *Streptococcus viridans*. In patients who have been followed over sufficiently long periods of time, the incidence of this complication is probably 25 per cent. (4) There are more rare complications such as aneurysmal dilatation or rupture. The first of the above-named complications appears in childhood, whereas the others are more apt to be problems of adult life, particularly of the third and fourth decades.—Robert E. Gross, M.D., and Luther A. Longino, M.D., The Patent Ductus Arteriosus, *Circulation*, January 1951.