

FURTHER STUDIES ON THE EPIDEMIOLOGY OF LOBAR PNEUMONIA.

By ERNEST G. STILLMAN, M.D.

(From the Hospital of The Rockefeller Institute for Medical Research.)

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Previous studies on the epidemiology of lobar pneumonia have shown that although pneumococcus is present in the mouths of about 50 per cent of normal individuals, it is extremely rare to find pneumococcus of Type I or Type II in the normal mouth except in individuals who have been in intimate association with patients suffering from lobar pneumonia due to organisms of these types. The observations of Dochez and Avery¹ suggest that in many instances lobar pneumonia may be due to contact infection. The source of such infection may be either an individual who has recovered from lobar pneumonia but who still harbors in his mouth the infectious microorganism, or a healthy carrier who has acquired the organism from association with a case of lobar pneumonia.

In the present paper are reported, first, the varieties of pneumococcus isolated from cases of lobar pneumonia admitted to the Hospital of The Rockefeller Institute during the past 5 years, second, the varieties of pneumococcus found in the mouths of normal individuals, third, a study of the types of pneumococcus present in the mouth secretions of members of households where cases of Type I and Type II pneumonia have occurred, fourth, the types of pneumococcus obtained from the dust of rooms in which no case of pneumonia is known to have occurred, fifth, the types of pneumococcus obtained from the dust in homes where pneumonia of Type I or Type II has occurred, and sixth, two epidemics of pneumonia.

¹ Dochez, A. R., and Avery, O. T., *J. Exp. Med.*, 1915, xxii, 105.

Varieties of Pneumococcus Concerned in the Production of Lobar Pneumonia.

During the past 5 years a study has been carried on of the types of pneumococcus isolated from 454 cases of lobar pneumonia admitted to the wards of the Hospital of The Rockefeller Institute. These organisms have been isolated from sputum, from blood cultures, or directly from the lung. In many instances they have been isolated from more than one of these sources and classified in the biological group already described by Dochez and Gillespie.² The results of this classification are shown in Table I.

TABLE I.
Types of Pneumococcus Causing Lobar Pneumonia in 454 Cases.

Pneumococcus.	Incidence.	
		<i>per cent</i>
Type I.....	151	33.26
“ II.....	133	29.29
“ II a.....	6	1.32
“ II b.....	4	0.88
“ II x.....	9	1.98
“ III.....	59	12.99
“ IV.....	92	20.26

The incidence of Types II a, II b, and II x, subvarieties of Type II, described by Avery,³ has only been determined during the last 2 years.

Varieties of Pneumococcus in the Normal Mouth.

Pneumococci were isolated in 116 instances from the saliva of 297 normal individuals in whom no history of contact with a previous case of lobar pneumonia could be obtained. In five instances two types of pneumococci were isolated from the same individual. Pneumococcus Type I was isolated only once; Pneumococcus Type II was not found among these 297 healthy individuals. Among the 39 per cent showing pneumococcus in the mouth secretions, the dis-

² Dochez, A. R., and Gillespie, L. J., *J. Am. Med. Assn.*, 1913, lxi, 727.

³ Avery, O. T., *J. Exp. Med.*, 1915, xxii, 804.

TABLE II.

Types of Pneumococcus Isolated from the Saliva of Normal Individuals Not in Direct Contact with Lobar Pneumonia.

Pneumococcus.	Incidence.	
		<i>per cent</i>
Type I.....	1	0.8
“ II.....	0	0
“ II a.....	1	0.8
“ II b.....	7	5.8
“ II x.....	14	11.6
“ III.....	34	28.1
“ IV.....	64	52.9
Pneumococcus present.....	116	
“ absent.....	181	
	<u>297</u>	

tribution of types is in striking contrast to that which is found among individuals in direct contact with disease. In Table IV are given the results of the examinations of 184 normal individuals known to be in contact with a case of lobar pneumonia due to pneumococci of Types I and II. Among 107 normal individuals known to be intimately associated with a Type I infection, 15 per cent showed pneumococcus of the same type as that causing disease. Of the remaining 77 individuals, all of whom were in direct contact with a Type II infection, this organism was isolated in 5 instances (6 per cent). In all, pneumococci of the more strictly disease-producing types, I and II, were found in 11 per cent of individuals in direct contact with cases of lobar pneumonia due to these types; while among 297 individuals in whom no history of previous contact could be obtained, pneumococci of Types I and II were found in only 0.8 per cent.

The pneumococcus is found in the mouths of many normal individuals. In some the same type of pneumococcus is present constantly, while in others the types may vary from time to time or entirely disappear. In Table III is presented a study of the types of pneumococcus recovered from the saliva of 942 healthy persons.

From the saliva of 942 normal individuals including those in contact with lobar pneumonia one or more types of pneumococcus were

TABLE III.

Types of Pneumococcus Isolated from the Sputum of Normal Individuals, Including Those in Direct Contact with Lobar Pneumonia.

Pneumococcus.	Incidence.	
		<i>per cent</i>
Type I.....	34	7.0
“ II.....	22	4.5
“ II a.....	1	0.2
“ II b.....	26	5.3
“ II x.....	47	9.7
“ III.....	85	17.5
“ IV.....	271	55.8
Pneumococcus present.....	450	
“ absent.....	492	
	942	

isolated in 450 instances, or 47 per cent. In 492 individuals no pneumococci could be recovered at the time of examination. Type I pneumococcus was isolated from 34 individuals. 33 of these persons had recently been in close association with a case of lobar pneumonia due to the same type. In only one instance was there no history of contact. From 22 individuals Type II pneumococcus was obtained. 19 of these persons had recently been intimately associated with a case of lobar pneumonia of Type II. It is significant that only once was pneumococcus of Type II a isolated from a normal mouth. Yet this organism was responsible for six cases of pneumonia, or 1.32 per cent. On the other hand, Pneumococcus Type II b was found 26 times and Pneumococcus Type II x 47 times in normal mouths. In view of the relative frequency of Types II b and II x in normal mouths, these organisms, as those of Types III and IV, must be considered as normal inhabitants of the healthy mouth. It is not infrequent to find two types of pneumococcus at the same time in one mouth. But as yet a Type I and a Type II pneumococcus have never been found simultaneously in the same mouth.

Incidence of the Carrier Condition in Normal Individuals in Contact with Patients Suffering from Lobar Pneumonia.

Dochez and Avery¹ have shown that many individuals who come in contact with active cases of lobar pneumonia due to infection with Pneumococcus Type I and Type II carry in their mouth secretions a pneumococcus of the same type as that causing the disease with which they have been associated. In order to determine the frequency with which normal individuals acquire these types of pneumococcus, the following study was carried on.

A nurse was sent to the home as soon as possible after a patient suffering from pneumonia due to Type I or Type II had been admitted to the hospital. Specimens of sputum were collected from all members of the household; *i.e.*, all persons who had come in contact with the patient. In Table IV are presented the results of this study. This table includes all the cases which were studied from this point of view. It shows the incidence and type of pneumococcus found among the members of 52 households. From 28 of these homes came patients with lobar pneumonia due to Type I infection. Among the 107 members of these families 16, or 15 per cent, showed Type I pneumococcus. One or more positive contacts were found in 10 (36 per cent) of the homes. Type II pneumococcus was isolated from only 1 individual. 77 individuals from 24 homes in which a case of Type II pneumonia had occurred were studied. From 5, or 6 per cent, a Type II pneumococcus was isolated. In 5, or 21 per cent, of the 24 homes a positive contact was found. A Type I pneumococcus was not found among these individuals. Altogether, from a total of 52 cases of lobar pneumonia due to Type I and Type II, 15, or 28 per cent, gave rise to the carrier condition in at least one of their immediate associates. The total number of households examined was 52, and in 15, or 28 per cent, there were one or more persons who showed pneumococcus of Type I or Type II in their sputum. Of the 184 persons who composed these households 21, or 11 per cent, showed either a Type I or a Type II pneumococcus.

The average carrying period for Type I was 25 days, and for Type II 43 days. The carrying period was roughly estimated by taking the middle date between the last positive sputum and the first negative one. If the contact was still positive at the last examination, a plus sign is added.

TABLE IV.

Incidence of the Carrier Condition in Healthy Individuals in Contact with Lobar Pneumonia.

Case No.	Type of infecting pneumococcus.	Relationship of associates.	Type found in associates.	Duration of carrying period.
				<i>days</i>
2,746	I	Father. Mother. Sister T. " A.	IV No pneumococcus. IV IV	
2,751	II	Wife. Sister. Brother. Brother-in-law.	II x and III No pneumococcus. IV II b and IV	
2,786	II	Husband. Son. Daughter. Friend.	II x IV IV II	48
2,804	I	" Mr. O. " Mrs. O. " G. " H.	IV IV II x IV	
2,814	I	Wife. Brother.	IV II b	
2,815	I	Husband. Daughter R. " H. Friend.	No pneumococcus. I No pneumococcus. II x	6
2,816	I	Wife. Son.	No pneumococcus. I	31
2,821	I	Sister-in-law. Brother. Friend.	No pneumococcus. II II b	Undetermined.
2,824	I	Sister.	No pneumococcus.	
2,825	II	Wife. Son-in-law. Daughter.	II No pneumococcus. II x	48
2,827	II	Wife. Friend.	No pneumococcus. II b and III	
2,834	II	Sister. Niece T. " M. Nephew H. Friend C. " D.	IV IV IV II b and IV II b " III II b " IV	

TABLE IV—Continued.

Case No.	Type of infecting pneumococcus.	Relationship of associates.	Type found in associates.	Duration of carrying period.
				<i>days</i>
2,883	I	Son. Daughter. Friend S. " Y.	No pneumococcus. " " " " II x	
2,885	II	Maid J. " A. " M.	IV No pneumococcus. " "	
2,886	II	Sister C. " E. Niece. Brother-in-law.	" " II x No pneumococcus. IV	
2,890	II	Wife.	No pneumococcus.	
2,891	I	Sister. Niece E. " M. Brother-in-law.	" " " " " " " "	
2,892	II	Wife. Daughter X. " M. Son. Boarder.	" " II x III II x No pneumococcus.	
2,896	II	Mother. Sister. Brother.	IV IV II x	
2,901	I	Wife. Friend K.	I II x	80
2,906	I	Husband. Sister. Son.	No pneumococcus. " " " "	
2,908	I	Wife. Brother. Sister L. " A.	" " IV No pneumococcus. I	37
2,913	I	Mother. Brother.	No pneumococcus. IV	
2,917	I	Mother. Father. Brother C. " B. Sister S. " N.	IV No pneumococcus. III No pneumococcus. IV No pneumococcus.	

TABLE IV—Continued.

Case No.	Type of infecting pneumococcus.	Relationship of associates.	Type found in associates.	Duration of carrying period.
2,922	II	Wife.	II	<i>days</i> 70+
2,924	I	Daughter I.	No pneumococcus.	
		Wife.	" "	
2,925	I	Daughter K.	" "	
		" L.	I	25
		" A.	No pneumococcus.	
		Son.	IV	
2,926	II	Wife.	III	
		Daughter S.	No pneumococcus.	
		" A.	" "	
		" R.	III	25
		Son J.	I	
2,934	II	" M.	III	
		Friend M.	III	
		" F.	No pneumococcus.	
2,944	I	" L.	II	7
		" R.	No pneumococcus.	
		" N.	IV	
		" H.	II x	
		" C.	No pneumococcus.	
2,945	I	" K.	" "	
		Mother.	I	32
		Father.	II b	
		Husband.	I	28
		Friend M.	No pneumococcus.	
		" McC.	IV	
		Daughter M.	No pneumococcus.	
		" H.	I and III	16
		Son.	No pneumococcus.	
		Sister.	I and II x	17
2,946	II	Mother.	I	7
		Father.	I	35+
		Brother I.	No pneumococcus.	
		" M.	" "	
		" C.	III and IV	
		Sister E.	I	9
2,946	II	" Y.	No pneumococcus.	
		" S.	" "	
		Wife.	" "	
		Son.	IV	

TABLE IV—*Concluded.*

Case No.	Type of infecting pneumococcus.	Relationship of associates.	Type found in associates.	Duration of carrying period.
				<i>days</i>
2,952	I	Wife.	IV	
		Daughter.	No pneumococcus.	
2,954	I	Brother E.	" "	
		" J.	" "	
		Sister R.	" "	
		Cousin.	" "	
2,955	I	Wife.	I	21
		Son.	II x	
		Daughter.	I	5
2,968	I	Sister-in-law.	No pneumococcus.	
		Brother.	" "	
		Nephew J.	II b	
		" O.	IV	
2,971	II	Maid.	No pneumococcus.	
		Father.	" "	
2,976	II	Mother.	" "	
2,984	I	Brother.	IV	
		Nurse.	IV	
2,991	II	Sister.	IV	
2,996	I	Wife.	II x	
		Son.	No pneumococcus.	
M.M.	II	Wife.	IV	
		Mother-in-law.	IV	
		Nurse.	II x	

Summary.

Type.	No. of pneumonia households examined.	Households in which carriers were found.		Total contacts examined.	Positive contacts.	
			<i>per cent</i>			<i>per cent</i>
I.....	28	10	36	107	16	15
II.....	24	5	21	77	5	6
Total.....	52	15	28	184	21	11

Types of Pneumococci Obtained from Dust of Households in Which No Case of Pneumonia Had Occurred.

The presence of pneumococcus in dust has been a known fact for some time. Netter⁴ in 1897 was the first to recover a definite pneumococcus from dust. Previous workers, notably Emmerich,⁵ demonstrated the presence of Friedländer's bacillus in the dust of a room where there were many pneumonia patients. But at this early date the pneumococcus and Friedländer's bacillus were not clearly differentiated. The occurrence of the pneumococcus in dust has been lost sight of and very little significance has ever been attached to it. Its presence in dust has not been correlated with the occurrence of cases of pneumonia beyond a few casual references to the finding of pneumococcus in the dust of wards where there were many pneumonia patients.

In order to determine whether pneumococcus could be recovered with any regularity from dust the following study was carried out. The specimens of dust were collected as follows: A piece of paper was wrapped about a scrubbing brush which in turn was covered by a piece of cloth and then autoclaved. The dust was swept up with the sterile brush on to the paper which was then folded. This dust was mixed with sterile broth and 1 or 1.5 cc. of the mixture were immediately injected into the peritoneal cavity of a white mouse. Cultures were made from the heart's blood of the mouse.

In Table V are given the types of pneumococcus recovered from the dust of 62 rooms in which pneumonia had not occurred.

From these 62 specimens of dust, in 18 instances, or 29 per cent pneumococcus was recovered. In all but one instance these pneumococci belonged to those types which are normally found in the mouth. The specimen of dust from which the Type I pneumococcus was recovered came from a house where a known carrier of a Type I pneumococcus was visiting. From this study it is evident that pneumococcus can be easily recovered from dust. Furthermore, it appears that the strictly disease-producing types of pneumococcus, Types I and II, are not prevalent in dust when patients and healthy carriers of these types of pneumococcus are absent.

⁴ Netter, L. D., *Compt. rend. Soc. biol.*, 1897, iv, series 10, 538.

⁵ Emmerich, R., *Z. Hyg. u. Infektionskrankh.*, 1894, xvii, 167.

TABLE V.

Incidence of Pneumococcus in Dust from Rooms in Which Pneumonia Had Not Occurred.

Pneumococcus.	Incidence.	
		<i>per cent</i>
Type I.....	1	5.5
“ II.....	0	0
“ II a.....	0	0
“ II b.....	4	22
“ II x.....	3	16.6
“ III.....	2	11
“ IV.....	8	44.4
Pneumococcus present.....	18	
“ absent.....	44	
	62	

Types of Pneumococci Obtained from Dust of Households in Which Pneumonia of Type I and Type II Had Occurred.

Table VI shows the incidence and types of pneumococcus found in 183 specimens of dust from households where cases of Type I or Type II pneumonia had occurred.

TABLE VI.

Incidence of Pneumococcus in Dust in the Presence of Pneumonia.

Pneumococcus.	Incidence.	
		<i>per cent</i>
Type I.....	25	33.78
“ II.....	23	31.08
“ II a.....	0	0
“ II b.....	2	2.70
“ II x.....	2	2.70
“ III.....	2	2.70
“ IV.....	20	27.02
Pneumococcus present.....	74	
“ absent.....	109	
	183	

From 183 specimens of dust collected where cases of pneumonia due to pneumococcus of Type I or Type II had occurred, 74, or 40 per cent, showed pneumococcus. A Type I pneumococcus was found in 25 instances. In only one instance was a Type I pneumococcus recovered where a Type II pneumonia had occurred. This dust was collected 16 days after the patient had left his home. A Type II pneumococcus was recovered in 23 instances. In only one instance was a Type II pneumococcus found in the dust in the room where there had been a case of pneumonia due to Type I.

From this study it is evident that the highly parasitic pneumococci, Types I and II, are very prevalent in dust where cases of the same type of pneumonia have occurred. As the dust from only a comparatively small area of the floor was swept up, the organisms must have been present in a much larger proportion than these figures indicate.

In Table VII is presented a study of the types of pneumococcus obtained from the homes where a case of Type I or Type II pneumonia had occurred. As a rule, the dust was collected only from the patient's bedroom, but in some homes specimens were also obtained from the living-room and other bedrooms. Of 30 homes where a case of Type I pneumonia had occurred, in 13 instances, or 43 per cent, a Type I pneumococcus was recovered from at least 1 room. In 2 instances a Type I pneumococcus was recovered from 2 rooms. In all, 44 rooms were examined. From 15 of these rooms, or 34.08 per cent, a Type I pneumococcus was recovered. No Type II pneumococcus was recovered from a Type I home. Of 22 homes where a case of Type II pneumonia had occurred, in 13 instances, or 59 per cent, a Type II pneumococcus was discovered in the dust of at least 1 room. In 3 homes a Type II pneumococcus was recovered from 2 rooms. Of the 27 rooms which were examined, in 16, or 59 per cent, pneumococci of Type II were recovered. In only one instance was a Type I pneumococcus recovered from the dust of a Type II house. This occurred 16 days after the patient had left the house.

A comparison of Tables IV and VII shows that in the 28 Type I households in 3 instances the dust was positive, but no contact was found; in 2, the dust was negative, but a positive contact was present;

TABLE VII.

Incidence of Pneumococci in Dust from Homes Where a Case of Pneumonia Occurred.

Case No.	Type of infecting pneumococcus.	Room.	Time after removal of patient to hospital.	Day of disease on admission.	Type of pneumococcus.	Condition of rooms.
2,746	I	Patient's bedroom.	0	6	No pneumococci.	Dirty and dark.
2,804	I	" "	3	6	" "	
2,814	I	" "	3	2	" "	Clean, but dark.
		" "	11		" "	
2,815	I	" "	1	4	I	Light, moderately clean.
		" "	12		I	
2,816	I	" "	1	6	I	Dark, fairly clean, poorly ventilated.
		" "	10		No pneumococci.	
2,821	I	" "	1	6	I	
		" "	10		No pneumococci.	
2,824	I	" "	14	3	" "	Very dirty and dark.
2,825	II	" "	1	1	III	Small, dark.
		" "	13		II	
		" "	49		No pneumococci.	
2,827	II	" "	3	3	II	Clean, light, and small.
		" "	10		II	
		" "	19		No pneumococci.	
2,834	II	" "	5	5	IV	Moderately clean, fairly well ventilated.
		" "	16		I	
2,852	I	" "	2	4	No pneumococci.	Large, clean, and light.
		" "	23		" "	
2,853	II	" "	8	2	" "	Very clean, light, well ventilated.
		" "	23		" "	
2,854	II	" "	4	3	" "	
		" "	14		" "	
2,858	I	" "	2	2	I	Moderately clean and light.
		" "	14		IV	
2,868	II	" "	2	4	No pneumococci.	Moderately light, well ventilated.
2,869	II	" "	3	2	" "	Clean.
		" "	18		" "	
2,874	I	" "	3	3	" "	Clean.
		" "	10		" "	
2,879	II	" "	2	2	" "	
		" "	15		" "	

TABLE VII—Continued.

Case No.	Type of infecting pneumococcus.	Room.	Time after removal of patient to hospital.	Day of disease on admission.	Type of pneumococcus.	Condition of rooms.
2,880	I	Patient's bedroom.	2	3	IV	Moderately clean,
		" "	13		IV	well ventilated.
2,881	II	" "	2	6	IV	Dark, poorly ven-
		2nd " "	2		IV	tilated.
		2nd " "	13		IV	
2,883	I	Patient's " "	5	4	No pneumococci.	Fairly clean but
		" "	15		" "	small.
2,885	II	" "	3	2	II	Clean.
		" "	13		No pneumococci.	
2,886	II	" "	3	4	II	Fairly clean but
		" "	14		No pneumococci.	dark.
2,890	II	" "	2	4	II	
		" "	15		No pneumococci.	
2,891	I	" "	1	3	" "	Clean.
		" "	23		" "	
2,892	II	" "	1	5	II	Moderately clean,
		" "	23		II	fairly well ven-
		" "	29		No pneumococci.	tilated.
2,896	II	" "	1	4?	II	Fairly clean, well
		" "	24		No pneumococci.	ventilated.
2,901	I	" "	2	5	I	Fairly clean, well
		" "	25		I	ventilated.
		" "	40		I	
		" "	50		I	
		" "	72		No pneumococci.	
		" "	92		" "	
2,906	I	" "	2	2	I	Large, clean.
		" "	21		No pneumococci.	
2,908	I	" "	3	5	I	Fairly clean.
		" "	18		No pneumococci.	
2,913	I	" "	2	5	" "	
		" "	13		" "	
2,917	I	Living-room.	8	6	II x	Fairly light.
		1st sick room.	8		No pneumococci.	Moderately clean.
		1st " "	22		" "	
		2nd " "	8		" "	

TABLE VII—Continued.

Case No.	Type of infecting pneumococcus.	Room.	Time after removal of patient to hospital.	Day of disease on admission.	Type of pneumococcus.	Condition of rooms.
2,922	II	Living-room.	3	3	II	Fairly clean, moderately ventilated.
		"	22		No pneumococci.	
		"	37		" "	
		"	70		" "	
		Patient's bedroom.	3		II	
		" "	18		II	
		" "	37		II	
2,924	I	" "	57	II	Fairly light and ventilated.	
		" "	70	No pneumococci.		
		" "	3	" "		
		" "	21	" "		
		Living-room.	3	" "		
2,925	I	Patient's bedroom.	1	5	" "	Small, dark, moderately clean.
		" "	16		I	
		" "	29		I	
		" "	45		No pneumococci.	
		Living-room.	2		" "	
2,926	II	" "	29	" "	Clean.	
		" "	45	" "		
		Patient's bedroom.	6	4		" "
		" "	6			" "
		" "	20			II
" "	39	II				
" "	55	No pneumococci.				
2,934	II	" "	5	4	" "	Clean.
		" "	14		" "	
2,944	I	1st "	3	5	IV	House thoroughly cleaned before second dust specimens were collected.
		1st "	16		No pneumococci.	
		1st "	53		II x	
		2nd "	3		I	
		2nd "	16		No pneumococci.	
		Mother's room.	3		I	
		" "	16		No pneumococci.	
2,945	I	" "	53	II x	Dirty, dark, but fairly ventilated.	
		Living-room.	16	No pneumococci.		
		" "	3	I		
		" "	17	IV		
		" "	35	IV		

TABLE VII—Continued.

Case No.	Type of infecting pneumococcus.	Room.	Time after removal of patient to hospital.	Day of disease on admission.	Type of pneumococcus.	Condition of rooms.
2,945	I	Patient's bedroom.	3		IV	Fairly clean. Light, clean, well ventilated.
		" "	17		IV	
		" "	35		IV	
2,946	II	" "	1	3	No pneumococci.	
		" "	17		" "	
2,949	I	" "	24	8	" "	
2,952	I	" "	3	2	" "	
		" "	21		" "	
		Living-room.	3		" "	
2,954	I	" "	21		" "	
		" "	5	4	" "	
		" "	19		" "	
2,955	I	Patient's bedroom.	5		" "	
		" "	19		" "	
		" "	4	6	I	
		" "	13		IV	
2,968	I	Living-room.	4		No pneumococci.	
		" "	13		" "	
		" "	38		I	
		" "	52		No pneumococci.	
2,971	II	" "	3	5	" "	
		" "	19		IV	
		Patient's bedroom.	3		No pneumococci.	
2,976	II	" "	19		" "	
		" "	2	4	II	
		Living-room.	2		No pneumococci.	
2,984	I	" "	26		II	
		" "	26		No pneumococci.	
		" "	3	3	" "	
		" "	14		" "	
2,991	II	" "	41		" "	
		Patient's bedroom.	3		" "	
		" "	14		II	
2,984	I	" "	41		No pneumococci.	
		" "	7	5	" "	
2,991	II	" "	4	1	II	

TABLE VII—*Concluded.*

Case No.	Type of infecting pneumococcus.	Room.	Time after removal of patient to hospital.	Day of disease on admission.	Type of pneumococcus.	Condition of room.
2,991	II	Patient's bedroom.	26		No pneumococci.	
		Living-room.	4		II	
2,996	I	"	26		No pneumococci.	
		"	1	3	II b	
		"	15		No pneumococci.	
		Patient's bedroom.	1		" "	
M.M.	II	" "	15		" "	
		Another "	1		I	
		" "	15		I	
		Patient's present room.	0	?	II	
F.I.	I	Patient's present room.	0		No pneumococci.	
		Patient's bedroom.	1	?	I	

Summary.

Type.	No. of pneumonia households examined.	Households giving rise to positive dust.		Total No. of rooms examined.	Positive rooms.	
			<i>per cent</i>			<i>per cent</i>
I.....	30	13	43	44	15	34.08
II.....	22	13	59	27	16	59.25
Total.....	52	26	50	71	31	43.66

in 8, the dust and at least one individual showed a Type I pneumococcus; while in 15, a Type I pneumococcus was recovered neither from the dust nor from a member of the household. In the 22 Type II households, in 10 instances the dust alone was positive; in 1, an individual alone was positive; in 3, a Type II pneumococcus was recovered from both the dust and from a member of the household; and in 8, neither the dust nor an individual showed a Type II pneumococcus. In these 50 households in 13 instances the dust alone

was positive, while in only 3 was the dust negative in the presence of a positive contact.

Individuals or specimens of dust were studied from 54 households where a case of pneumonia due to a pneumococcus of Type I or Type II had occurred. Of the 30 Type I households, 14, or 46 per cent, showed either a positive human contact or a positive dust. From 24 Type II households 15, or 62 per cent, showed either a positive human contact or a positive dust. In other words, at the time of their admission to the hospital, the homes of over 53 per cent of the patients suffering from a pneumonia due to Type I or Type II were infected by a pneumococcus of the same type.

As a rule, the dust became negative before the contacts. But in two instances positive dusts were obtained after the carriers in the households had become negative. It is interesting that in the two homes which showed a positive dust for the longest time lived the two most persistent carriers. In Case 2,901, Type I, the dust was positive for 50 days, while the carrier had not become negative at the end of 80 days. In Case 2,922, Type II, the carrier was still positive at the end of 70 days and the dust was positive on the 57th day.

Two Pneumonia Epidemics.

Through the courtesy of the State Department of Health and the local health officer of Rochester, N. Y., I have had an opportunity of studying two epidemics of pneumonia in institutions.

One epidemic occurred in a boys' asylum. At the time of the epidemic there were over 200 boys in this institution, but the 6 cases of pneumonia were limited to the boys occupying two of the four dormitories. 3 boys in each dormitory developed pneumonia; from the sputum of 3 of the 6 boys a Type I pneumococcus was recovered, from another a Type II x; and from a 5th a Type IV; from 1, no pneumococcus was obtained. The absence of Type I pneumococcus from 3 cases may be due to the fact that this study was not made until the patients were convalescent. The sputum of the other 56 boys who slept in the two dormitories was studied. From the saliva of 6, or 10 per cent, a Type I pneumococcus was isolated.

Three specimens of dust were taken at random from each of the

two dormitories. As these rooms were very clean this dust had to be swept out from between the chinks of the floor boards. One specimen of dust from each dormitory showed a Type I pneumococcus. Of the other four specimens two showed a Type IV, and from two no pneumococcus was obtained. Six specimens of dust from the vacant room used as a ward failed to show a Type I pneumococcus, but a pneumococcus of Type II and a pneumococcus of Type II b were recovered.

In this epidemic 50 per cent of the cases of pneumonia were found to be due to Type I pneumococcus; from 10 per cent of the healthy contacts and from the dust a Type I pneumococcus was recovered.

The other epidemic occurred in the Rochester State Hospital for the Insane. Here six cases of pneumonia occurred among the inmates of one ward of over 200 persons. A Type I pneumococcus was recovered from four of the patients, but the other two patients died before the type of infecting pneumococcus was determined. Each of the patients who died had shared a double room with one of the patients who showed a Type I pneumococcus. A Type I pneumococcus was also recovered from the dust of one of these two bedrooms. The saliva of 148 inmates of this ward was studied. In five instances a Type I, and in one a Type II pneumococcus were isolated. In all, nine specimens of dust were examined. In one instance a Type I, in one, a Type III, and in three, a Type IV pneumococcus was found.

In this epidemic six cases of pneumonia occurred in the ward of an institution. A Type I pneumococcus was recovered from four of the six patients, from 2 per cent of the healthy contacts, and from the dust.

Related Cases of Pneumonia.

Several instances which seem to be contact infections or infections from the same source have been studied. In the first instance a mother daily visited her son who was critically ill with a Type I pneumonia. The mother contracted a bad cold and developed pneumonia due to a Type I pneumococcus 11 days after her son was taken ill. Another case was that of an actor who was admitted to the hospital with a Type II pneumonia. The next day an actor who

shared the same dressing-room developed a Type II pneumonia. Before the end of the week an electrician at the same theater became ill with pneumonia. He also showed a Type II pneumococcus. In a third instance Miss H. (type of pneumonia not determined) was taken to a private hospital by Mrs. A. who developed a Type II pneumonia in a few days. Mr. B. helped to nurse Mrs. A. and shortly fell sick with a Type II pneumonia. In another instance a patient who had just recovered from a Type I pneumonia left the hospital March 9. The next day he went to see his brother who had developed a Type II pneumonia. On March 12 this patient, who had just recovered from a Type I infection, developed a pneumonia due to a Type II pneumococcus. The following case suggests the possibility of an infection by a healthy carrier. A patient was admitted to the hospital suffering from pneumonia due to *Pneumococcus* Type I. Specimens of sputum were obtained from the other members of the household. One 5 year old daughter was found to be a Type I pneumococcus carrier; the other two members of the household were negative. The dust from the room the patient had previously occupied in this house also showed a Type I pneumococcus. The little girl was sent to board with friends while her mother was in the hospital. She spent 3 days with the first family and then went to visit in the Bronx. 6 days after she left, a child in the home where she had visited came down with pneumonia due to *Pneumococcus* Type I. Specimens of sputum from the other members of this household were negative, but from the dust in the sick child's room a pneumococcus of Type I was isolated. The daughter of the original patient visited in the Bronx for 10 days. No cases of pneumonia developed in this home and the sputum of the members of this family as well as the dust failed to show the presence of *Pneumococcus* Type I. The child next went to visit friends in Brooklyn. Although the sputum from the members of this household were negative, from the dust a Type I pneumococcus was recovered.

DISCUSSION.

The results of the work detailed in this paper confirm the previous observations of Dochez and Avery on the occurrence of healthy carriers of disease-producing types of pneumococcus. Consideration

of the results of study over a period of years of the types of pneumococcus inducing lobar pneumonia shows that in the majority of instances infection is due to organisms belonging to Type I or Type II. The minority of cases, on the other hand, are due to infection with pneumococcus of Types III and IV.

Comparison of the types of pneumococcus obtained from the mouth secretions of normal persons with those isolated from individuals with lobar pneumonia shows the existence of two general classes of organisms. One of these, which consists of Types I and II, occurs only in association with disease. The other, which includes Types III and IV and the atypical Type II organisms, also causes pneumonia but these organisms are commonly found in normal healthy mouths. Rarely Types I and II have been found in the mouth secretions of normal individuals who give no history of association with cases of pneumonia. On the other hand, organisms of Types I and II have been found in 11 per cent of normal individuals who have been in intimate association with a case of pneumonia of the same type.

Although the presence of pneumococcus in dust has been known for some time, little significance has been attached to it. The results of this work show that pneumococcus can be easily recovered from dust. The types of pneumococcus found reflect accurately the pneumococcal flora of the mouth of the members of these households. Pneumococcus of Types I and II is rarely found in dust except where a case of pneumonia due to the same type of pneumococcus has occurred. In view of the ease with which dust can be disseminated it is not surprising that in a few instances a Type I or Type II organism was recovered from the dust which did not correspond to the type of pneumococcus producing the disease.

The occurrence of these disease-producing types of pneumococcus in the dust suggests the possibility that air-borne infection may play a part in the production of pneumonia. On the other hand, the mere presence of the disease-producing types of pneumococci in the mouth will not initiate disease. But if a susceptible individual comes in intimate contact with a case of pneumonia there is grave danger of his contracting the disease.

These facts suggest the following conclusions concerning the epidemiology of lobar pneumonia. Infection with pneumococcus of

Types I and II must be regarded as dependent upon either direct or indirect contact with a previous case of lobar pneumonia due to the same type of organism. These types of infection are either acquired by direct contact with a previous case of pneumonia, by association with a healthy carrier of one of these types of pneumococcus, or possibly by an air-borne infection from dust which has been infected. Infection with the sputum types of pneumococcus, namely Types III and IV and the atypical strains of Type II, may be autogenic, or due to the acquisition by the individual of one of these types to which he is especially susceptible.

SUMMARY.

1. Pneumococci of Type I and Type II are responsible for the majority of the cases of lobar pneumonia.
2. Among the pneumococci found in the mouths of healthy individuals Type IV predominates, Type III is frequent, and atypical organisms of Type II are occasionally found.
3. Healthy persons intimately associated with cases of lobar pneumonia may harbor in their mouth secretions the highly parasitic pneumococcus of Types I and II.
4. Occasionally a carrier of Type I or Type II pneumococcus is encountered in whom it is impossible to trace any contact with an infected patient.
5. From the dust of homes where cases of pneumonia due to Types I and II have occurred, pneumococci of the same type may be recovered.