A STUDY OF PNEUMONIA IN A RURAL AREA IN SOUTHERN ALABAMA

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The present study was undertaken to determine certain basic facts in relation to pneumonia in a rural community in the South; it covers a period of 6 months, October to April, 1927–1928. Our field laboratory[1] was established in Andalusia, Alabama, a town of about 4,000 inhabitants, the center of a rather sparsely settled rural community where farming and lumbering are the chief industries. The area covered in the study comprises approximately a thousand square miles, and has a population of about 35,000, the great majority of whom are white.

Types of Pneumococci Isolated

Fifty-eight cases of pneumonia were seen in the Andalusia area during the course of the study. A summary showing the types of pneumococci isolated from these cases is given in Table I.

The striking feature of this series of cases is the small number of fixed types of pneumococci that were isolated. Pneumococci of the heterogeneous Type IV group were the prevailing organisms.

Severity of the Disease

In Table II we have classified the cases of pneumonias according to their severity as correlated with the type of pneumococcus isolated.

Lobar pneumonia takes a much heavier toll in the northern than in the southern United States. In 1925, for example, the death rates

[1] We are greatly indebted to Col. C. A. Reasoner of the U. S. Army Medical Service, for help and advice in selecting equipment for our field laboratory.

per 100,000 from all types of pneumonia in whites and negroes for certain typical states were as follows:

	White	*Colored*
New York	105.3	367.4
Massachusetts	116.4	230.5
Pennsylvania	116.7	366.4
Alabama	81.4	135.1

TABLE I

Types of Pneumococci Isolated Compared with Data from New York City (Monograph 7, Rock. Inst.)

Pneumococcus Type	No. of cases	Alabama	New York City
		per cent	*per cent*
I	7	12.3	33
II	0	0.0	31
IIx	2	3.5	—
III	1	1.7	12
IV	40	68.5	24
Pneumococcus not isolated	8*	14.0	—

* Two of this group had a pneumonia due to staphylococcus, one following a periostitis—the other a case of senile dementia, while one case had a hemolytic streptococcus in pneumonia following an automobile accident. The remaining five were children from 1 to 8 years of age, from whom it was difficult to get sputum. They were presumably pneumococcus pneumonias, Type IV.

TABLE II

Severity of the Disease

Type	Mild	Moderate	Severe	Fatal
I	0	3	4	0
IIx	0	0	0	2
III	0	0	1	0
IV	21	11	6	2
Pneumococcus not isolated	4	1	1	2*
	25	15	12	6

* Staphylococcus pneumonia.

Since no morbidity data are available, it is not certain whether pneumonia is less prevalent in the south than in northern states or equally prevalent but less fatal.

Tables I and II suggest that pneumococcus pneumonia may be as frequent in the isolated rural districts in the south as in the large cities in the north, but is much less fatal.

Age Distribution

In Table III we have summarized the distribution of cases of pneumonia by age groups. The striking feature of Table III is that pneumonia due to Type IV pneumococcus occurred chiefly in children under 15 years of age, whereas pneumonias due to the fixed types of pneumococci were seen chiefly in adults.

TABLE III

Age Distribution of Cases of Pneumonia in Southern Alabama

Age	Total cases	Fixed types of pneumococci	Type IV	Pneumococcus not isolated
Under 1 year	1	0	1	0
1– 4 years	9	0	6	3
5–14 "	26	4	19	3
15–44 "	15	4	10	1
45–64 "	4	2	2	0
65 and over	3	0	2	1
	58	10	40	8

Seasonal Distribution of Pneumonia

The community studied was free to a great extent from acute respiratory disease until the first week in January, though there had been mild outbreaks of "colds" in neighboring counties. Daily records were made of maximum and minimum temperature, relative humidity and rainfall. The exact day of onset of each case of pneumonia was recorded. Directly following a week of low temperature, Jan. 1, there occurred a widespread epidemic of colds. Aerobic cultures from the nasopharynx of many individuals during this outbreak showed (a) a great preponderance of pneumococci Type IV, of low virulence to white mice, (b) a large number of influenza bacilli of various types. The time relationship between the cold weather and the prevalence of pneumonia is shown in Chart I. The data seem to

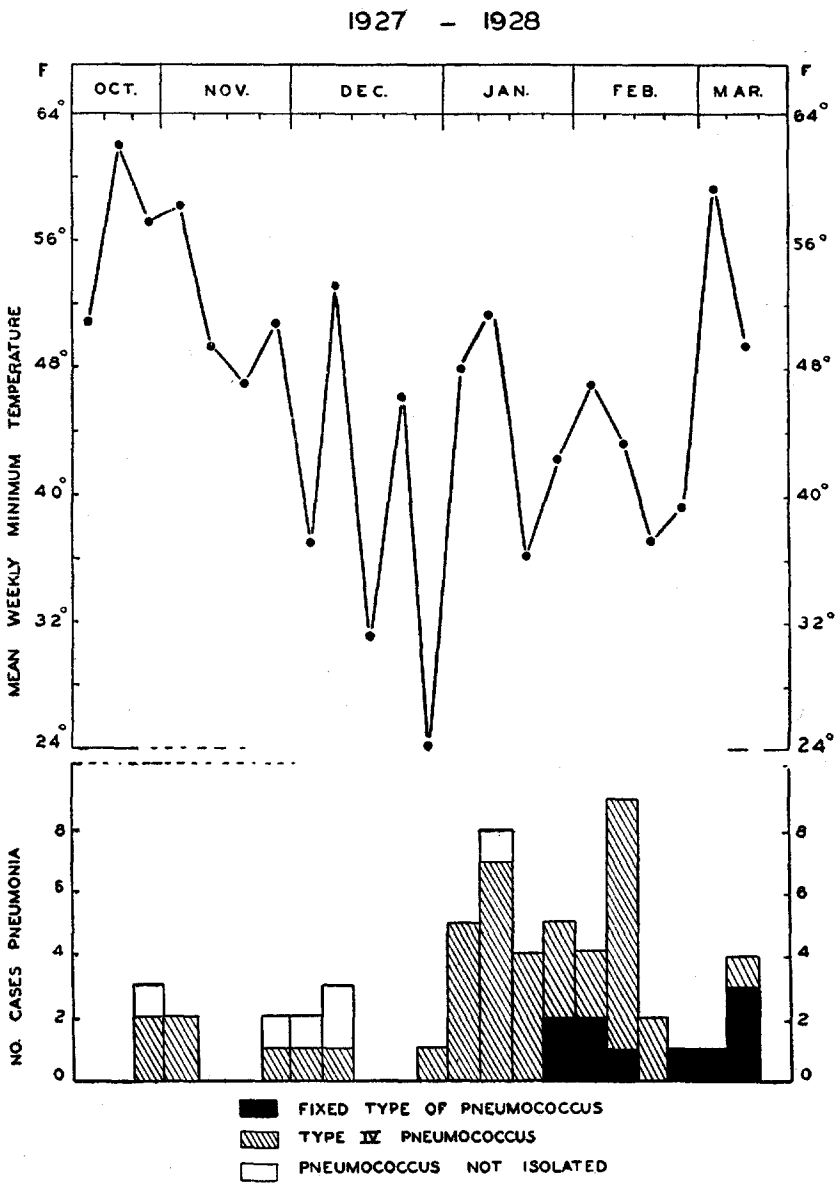

CHART I. Seasonal distribution of pneumonia, Andalusia, Alabama.

indicate that a period of cold weather with attendant suffering and exposure bore a definite relationship to the onset of pneumonia. The sequence was first, cold weather; second, an epidemic of colds; third, pneumonia. The cases of pneumonia did not occur during the coldest weather but 2 to 4 weeks after the weather became warmer.

In individual cases the acute colds developed into pneumonia, usually on the sixth or seventh day of the cold, often following exposure while riding several hours in a wind, or getting rain-soaked and thoroughly chilled when returning from school. The great proportion of the cases occurred in children under 15 years of age and the invading pneumococcus was usually Type IV. Frequently two or more members of the family developed pneumonia at the same time.

TABLE IV

Relationship of Exposure and of Acute Colds to Pneumonia

	Type of pneumococcus			
	Fixed types	Type IV	Pneumococcus not isolated	
Sudden onset—no exposure or "acute cold"	2	4	2	
Exposure but no "cold"	1	1	0	Total
	3	5	2	10
"Acute cold" antedating pneumonia 5–10 days	6	25	3	
"Acute cold" plus exposure to chilling rain, etc.	1	10	3	Total
	7	35	6	48

The relationship of the onset of pneumonia to chilling and exposure and also to acute colds is given in Table IV.

The clinical symptoms in these cases of Type IV pneumonia were typical of lobar pneumonia, but the physical signs were not characteristic of those found in cases of lobar pneumonia due to the fixed and more virulent types of pneumococcus.

The signs of consolidation in the lung were typical but the area involved did not conform to the anatomical outlines of a single lobe. Often areas of consolidation in two different lobes in the same lung were found—sometimes both lungs were affected. The cases could not be called broncho-pneumonia, for small multiple areas of con-

solidation were not found, but rather large areas with typical massive consolidation, sometimes in the axilla but most often in the right base.

The epidemiology of these cases of pneumonia in a sparsely settled rural area is in direct contrast to pneumonia in our larger northern cities where adults are more commonly affected than children and family epidemics are rare; where the attack usually runs a severe course, may or may not be preceded by a cold, and where the physical signs are usually confined sharply to the anatomical outline of a lobe of lung.

It seems a tenable supposition that the isolation, poor roads, lack of frequent contact with one another and with the outside world, have produced in a community of people a low resistance to relatively avirulent pneumococci, whereas under more crowded conditions, there develops a community resistance to avirulent pneumococci, where pneumonia occurs as a rule following an invasion of one of the virulent fixed types of pneumococci.

The mode of life, customs, and habitations of the community studied are closely comparable with those of our forefathers one hundred years ago or more. It is interesting to note that the medical literature of 1810 to 1840 is full of references to epidemic pneumonia.

Warner (1), 1814, describes the epidemic prevailing in New England and New York State. He states "the disease is characterized by an initial chill and prostration and seems related to exposure to wet or cold." Cartwright (2) describes an epidemic in Natchez in 1826 and notes that atmospheric vicissitudes, exposure to inclement weather and intemperance predispose to the disease. MacBride (3), 1813, in describing an epidemic in St. John's Parish, South Carolina, states that most of the deaths occurred in field negroes, but the disease was also seen in whites of the lower classes. When an individual in a family was attacked, nearly all other members developed the disease. McCall (4), 1823, describes a family epidemic in Kentucky; Williamson (5) described an epidemic in 1813 in North Carolina and felt that cold and rain predisposed to the disease. Smith (6), Stearns (7), Mott (8), Mann (9), Eights (10), LeComte (11) and many others describe epidemics of lobar pneumonia in various parts of the eastern United States in the early part of the last century.

It seems probable that the pneumonia in the isolated rural community studied is comparable to the type of pneumonia of pioneer days in the United States, and that the increase of population and the

industrialization of the northern states, producing crowded conditions and frequent contacts, have resulted in the development of a population largely immune to avirulent strains of pneumococci, but responding to certain of the fixed virulent strains.

Family Epidemics of Pneumonia

In seven different families two or more members of the family were ill with pneumonia at the same time. This is contrary to the usual finding in the northern United States, where family epidemics of pneumonia are rare.

The intimate relationship of one case of pneumonia with another suggested the possibility of transmission of the disease from one member of a family to another by immediate contact. If this were the case, then one would expect to find that the various contacts with a case of pneumonia would harbor in their nasopharynx the type of pneumococcus corresponding to that found in the sputum of the patient. To determine this point, a study was made of the nasopharyngeal flora of 26 families in which one or more cases of pneumonia had developed.

Technique

Practically every case of lobar pneumonia which occurred in the area during the winter was seen in consultation with the family physician[2] as soon as the diagnosis of pneumonia was made (usually the second day of the disease). Cultures of the nasopharynx of all contacts were made at once, using the West tube. They were placed directly in blood broth, kept warm during transportation, and plated on 3% horse blood hormone agar plates as soon as possible. The plates were searched after 24 to 36 hours, and typical colonies were isolated and the organism identified. A total of seventy-three contacts were cultured, each of whom had been in close and frequent communication with the pneumonia patient. A summary of the findings is given in Table V.

It might be assumed from Table V that the thirty-two contacts with cases of Type IV pneumococcus who harbored type IV strains in their nasopharynx were infected by actual contact with the patient who was ill with pneumonia in the household. If this were the case, contacts with Type I and Type II pneumonias should harbor corresponding strains. This occurred in only five instances, whereas ten of

[2] There are about twenty-five general practitioners in the area.

the seventeen contacts with Type I pneumonia harbored not Type I but Type IV pneumococcus. It seemed probable, therefore, that some other factor than contact with a case of pneumonia was responsible for the prevalence of pneumococci in the nasopharynx of these individuals.

TABLE V

Prevalence of the Pneumococcus in the Nasopharynx of Individuals in Direct Contact with Pneumonia Patients

	Type of pneumonia in patients to whom contacts were exposed		
	Type I	Type II	Type IV
Contacts harboring pneumococcus:			
Type I	2*	0	0
Type II	0	3	0
Type III	0	1	0
Type IV	10	1	32
No pneumococci found	5	2	17

* Both these contacts developed Type I pneumonia within 3 days after their throat cultures were taken.

TABLE VI

Correlation of the Prevalence of Pneumococci in the Nasopharynx with an Acute Respiratory Infection

Type of pneumococcus found	Acute cold when examined	Just recovered from cold	No history of recent cold
I	2*	0	0
II	1†	0	2†
III	0	0	1†
IV	25	15	3
No pneumococcus found	6	13	5
Total	34	28	11

* Contact with Type I pneumonia.
† Contact with Type II pneumonia.

We have noted that practically all cases of pneumonia were preceded by an acute upper respiratory infection and that these colds occurred as family epidemics affecting all members. It seemed possible that these epidemic colds might be associated with an in-

creased prevalence of pneumococci. An analysis was made, therefore, to determine this point. See Table VI.

Table VI shows clearly that a large proportion of the individuals in this study who were harboring pneumococci had colds at the time or had just recovered from them. This is particularly true of the group of individuals who made up the families in which there was a case of Type IV pneumonia. Furthermore, the relative number of pneumococcus colonies on the blood agar plate cultures of the nasophaynx seemed to bear some relationship to the course of the cold. See Table VII.

Tables VI and VII give a very definite indication as to what occurred in these epidemics of colds and the relationship of the cold to pneu-

TABLE VII

Group of Contacts with Type IV Pneumonia; Table Showing Relative Prevalence of Pneumococci Type IV in Acute "Colds"

Proportion of pneumococcus colonies on the blood agar plate in relation to all other colonies	Number of cases			
	1st 3 days of cold	4th to 8th day	1st week after recovery	2nd week after recovery
50 to 100 per cent	1	5	3	0
25 to 50 per cent	0	3	5	1
Few (less than 25 per cent)	5	3	1	2
No pneumococci	2	3	3	7

monia. Within the first few days of the cold, pneumococci Type IV are found in the nasopharynx of those affected. From the fourth to the eighth day, the pneumococci have so increased as to outnumber all other organisms. As the patient recovers from the cold, the pneumococci disappear and the normal flora of the throat reappear, though pneumococci are frequently found for 10 days to 2 weeks after symptoms of cold have disappeared.

It seems probable that the contacts with cases of pneumonia, particularly the Type IV group, were not infected by their direct contact with a pneumonia patient. The more probable history is as follows: An epidemic of acute colds occurred in a family, usually affecting all members of the family. Coincident with the cold, pneumococci occurred in the nasopharynx in large numbers. In the great majority

of the colds, nasopharyngeal symptoms disappeared after 7 to 10 days, and gradually the pneumococci disappeared also. A small proportion of the individuals who had an infection with pneumoccci of the upper respiratory tract developed pneumonia on the fourth to eighth day of their cold. The attack often followed an exposure or chilling of the body surface, with a resultant extension of the infection from the upper to the lower respiratory tract. The pneumonia, therefore, was an incident in the course of an epidemic of colds.

If this is true, family epidemics of colds associated with pneumococci must have occurred in which no case of pneumonia developed. Such indeed was found to be the case. A complete epidemic of acute colds was studied in a small rural school—cultures being taken before the colds began, during the epidemic, and after the epidemic had ceased. A report of this epidemic, together with other similar studies, will be made in a subsequent communication.

The assumption might be made that the incitant of these colds is the pneumococcus—especially since there is some contributory evidence in addition to that already presented. One bit of evidence is that these colds were associated with a high leucocytosis—a white blood count of twelve to fifteen or even eighteen thousand being commonly found. Furthermore, one of the present investigators developed a clear-cut nasopharyngeal infection due to pneumococci which was acquired in the laboratory while working with the pneumococcus cultures and which ran a course similar to the family epidemics of colds. The appearance and disappearance of symptoms in this infection were closely correlated with the appearance and disappearance of pneumococci in the nasopharynx.

In one instance, a pure culture of pneumococci Type I was found in the nasopharynx on the second day of a cold in a person who was nursing a patient with Type I pneumonia. 3 days later the nurse developed pneumonia Type I. In two other instances mothers who were caring for children with pneumonia Type IV developed typical colds, and almost pure cultures of pneumococci Type IV were isolated from the nasopharynx on the first or second day of the cold.

But there is evidence also that pneumococci were merely contributory causes and perhaps did not initiate the colds at all. It will be noted from Table VII that pneumococci were not abundant in the

nasopharynx during the first 2 or 3 days of the cold, but were most prevalent from the fourth to the eighth day. This observation suggests that the pneumococci may be secondary invaders and that the cold was initiated by some unknown factor.

Another interesting observation in connection with these family epidemics of colds associated with pneumococci is that Pfeiffer bacilli were frequently found in abundance in association with the pneumocci. In general these organisms appeared later in the cold than the pneumococcus, and were present for a longer period after symptoms had disappeared. No constant type of Pfeiffer bacilli was encountered. Both hemolytic and non-hemolytic forms were found—

TABLE VIII

Table of Correlation between Incidence of "Colds" and Prevalence of Pneumococci and Pfeiffer Bacilli in the Nasopharynx

	Number of cases			
	Acute cold at present	Just recovered from cold	No history of recent cold	Total
Pfeiffer bacilli and pneumococci	11	6	0	17
Pfeiffer bacilli only	4	8	1	13
Pneumococci only	15	11	5	31
Neither pneumococci nor Pfeiffer bacilli	5	3	6	14

some requiring V + X factors for growth, others requiring only V factor. Some produced indol—others did not. There was some consistence in the type found in members of the same family but not in the group as a whole. A brief summary of these findings is given in Table VIII.

Table VIII indicates that Pfeiffer bacilli were frequently associated with pneumococci in the acute colds which occurred in the group of contacts with cases of pneumonia.

CONCLUSIONS

1. Pneumococcus Type IV of low virulence was the prevailing organism in fifty-eight cases of pneumonia studied in southern Alabama. Fixed types of pneumococci were not common.

2. Pneumonia was more prevalent in children from 5 to 15 years of age than in adults. As a rule, the disease ran a mild course.

3. Most of the cases of pneumonia gave a definite history of an acute cold antedating the attack of pneumonia by a period of 5 to 8 days. Exposure alone did not seem to predispose to pneumonia, but those with an acute cold who were exposed to chilling of the body surface frequently developed pneumonia.

4. There were seven "family epidemics" of pneumonia. In each instance there was a family epidemic of colds antedating the pneumonia. The pneumococcus was found in large numbers in the nasopharynx of those suffering from colds as well as in the pneumonia patients.

5. The epidemiology of pneumonia in the pioneer days of American history has many points in common with the epidemiology of pneumonia in a rural isolated area in southern Alabama today. This suggests that the crowded conditions and frequent contacts of modern city life have built up a community resistance to avirulent strains of pneumococci.

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