AN IMMUNOLOGICAL STUDY OF PNEUMOCOCCUS MUCOSUS.*

By FREDERIC M. HANES, M.D.

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

Although the older literature, reviewed by von Lingelsheim (1), contains a number of descriptions of encapsulated streptococci, the importance of organisms of this type as frequent producers of disease has only been fully recognized since the publications of Schottmüller (2), who found a well characterized organism, which he called *Streptococcus mucosus,* in various pyogenic processes and in lobar pneumonia. Many observers have since encountered this organism, occurring as it does in the most diverse pyogenic lesions, and its morphologic and biologic characteristics are well known.

Among seventy-four cultures isolated from patients with lobar pneumonia in the Hospital of The Rockefeller Institute in the course of the past two years, nine, or 12 per cent., have been classed provisionally as belonging to the group of encapsulated streptococci of Schottmüller. These organisms, through their power of producing a tenacious mucoid exudate in the peritoneal cavity of white mice, were readily separated from the larger group of encapsulated diplococci. At the same time, however, their cultural characteristics made it seem probable that they represented a variety of the pneumococcus rather than that they belonged to the streptococcus group.

With the hope of determining more exactly the relations of *Streptococcus mucosus* of Schottmüller to *Diplococcus pneumoniæ,* on the one hand, and to the streptococci, on the other, six of our nine organisms were selected for a comparative study of this problem. These six organisms were chosen at random from the nine in our possession. For convenience I shall refer to this group of organisms as *Pneumococcus* rather than *Streptococcus mucosus.* They were reobtained for this study from the dried spleens[1] of white mice which had died following a peritoneal injection of the sputum from

* Received for publication, September 15, 1913.

[1] It not infrequently happens that mice infected intraperitoneally with pneumococci show, in addition to a pneumococcus septicemia, an infection with the

patients suffering from lobar pneumonia, the spleens having been preserved *in vacuo* for several months (Neufeld and Händel (3)). Two other pneumococci and two organisms of the streptococcus group were selected for study in addition to these six. The distinguishing characteristics of all the organisms are given for comparison in table I.

The six representatives of the *Pneumococcus mucosus* group (Nos. 19, 26, 42, 54, 68, and 96) possess identical properties, and these will be described in detail. Of the two other pneumococci, one is an organism secured from Dr. Neufeld and is the type representative of Dochez's (4) group I; the other belongs to Dochez's group II. One of the streptococci (No. 174) is a typical hemolyzing *Streptococcus pyogenes,* while the other (No. 49) is exactly described by the name *Streptococcus mucosus.* This organism was selected for comparative study because it possesses a distinct capsule and has the power of producing a mucoid exudate in the peritoneal cavity of a white mouse, having at the same time the cultural and morphological characters of a streptococcus. Its characteristics, as detailed in table I, would seem to place it nearer the streptococci than the pneumococci. It was recovered from the sputum of a non-fatal case of lobar pneumonia.

As stated above, the six members of the group of *Pneumococcus mucosus* chosen for this study exhibit identical properties; they likewise conform to Schottmüller's description of *Streptococcus mucosus.* There can be no doubt, then, that they belong to the same group as the organisms he described, and a brief description of this group will be given.

Pneumococcus mucosus occurs in diplococcal form, often arranged in short chains of from four to about sixteen members. These are surrounded by a broad mucoid capsule which, in purulent exudates,

bacillus of mouse typhoid (*B. typhi murium*). Both organisms are often present in the blood, but this may show only pneumococci, while smears of the exudate from the peritoneal cavity show that both are present. Under such conditions the dried spleens in which the pneumococci are preserved are contaminated with *B. typhi murium,* and the recovery of the pneumococcus in pure culture is very difficult. Several of our spleens were thus contaminated, and other methods of purification having failed, we resorted with complete success to the production in rabbits of an anti-mouse typhoid serum. These sera will prevent the growth of the mouse typhoid in the animal body, whereas pneumococci develop as usual.

TABLE I.

Organism.	Morphology.	Solubility in sodium taurocholate.	Growth on blood agar plates.	Plain agar.	Litmus-milk.	Bouillon.	Hiss's serum inulin medium.	Exudate in peritoneal cavity of mice.
Six strains of *Pneumococcus mucosus* (Nos. 19, 26, 42, 54, 68, 96)	Diplococci single and in short chains; cocci round or slightly flattened, and possessing broad, mucoid capsules	Soluble	Large round drop-like mucoid colonies, colorless and translucent; greenish brown discoloration of medium	Very delicate, scanty, translucent growth; media not clouded	Acid and coagulated in 24 hrs.	Moderately turbid; very slight sediment	Acid and coagulated in 24 hrs.	Mucoid, tenacious, easily drawn out into thread
Pneumococcus I and II	Lancet-shaped diplococci with delicate capsules	Soluble	Delicate, discrete, drop-like colonies; greenish brown discoloration of medium	Very delicate, scanty, translucent growth; media not clouded	Acid and coagulated in 24 hrs.	Moderately turbid; very slight sediment	Acid and coagulated in 24 hrs.	Not mucoid or tenacious.
Organism 49, *Streptococcus mucosus*	Small round cocci arranged in short or long chains	Not soluble	Grayish translucent colonies	Abundant growth; media not clouded; surface rather dry	Acid and coagulated in 24 hrs.	Turbid; moderately heavy sediment	No acid production or coagulation	Mucoid and tenacious.
Streptococcus longus	Small round cocci arranged in chains	Not soluble	Grayish translucent colonies; wide area of hemolysis	Abundant small grayish colonies; media clouded	Acid and coagulated in 24 hrs.	Turbid; heavy sediment	No acid production or coagulation	Not mucoid or tenacious.

merges almost imperceptibly into the characteristic tenacious material produced so abundantly by the growth of this organism in the animal body. The capsule persists in cultures upon artificial media and is always easily demonstrated. The organism is round or slightly flattened in shape and varies in size, even in the same culture. It gives the impression, especially when stained by Gram's method, of being larger and coarser than other pneumococci.

Pneumococcus mucosus, in common with other pneumococci, grows best upon a medium containing blood serum or whole blood. Growth is very scanty or absent upon plain agar, while relatively few of the transplanted organisms grow even upon a favorable medium such as blood agar. It is necessary, in order to secure luxuriant growth, to inoculate heavily any medium used. The cultures dry out rapidly, even under the favorable conditions of ice box temperature, and after ten days they are usually sterile. The individual colonies are round, moist, colorless, and translucent. When several colonies have become confluent, as they do very readily, they tend to run down the surface of the agar slant, presenting the appearance of a dependent drop of clear, tenacious, mucoid material. Smear cultures on blood agar present, as a rule, a smooth, homogeneous, translucent growth, which is colorless itself, but causes a greenish brown discoloration of the medium. With the platinum loop, the growth can be drawn out into short tenacious threads. Bouillon, if carefully prepared and heavily inoculated, produces a moderately luxuriant growth, with little or no tendency to sedimentation. Growth on gelatin is slight and there is no liquefaction. Litmus-milk turns red and coagulates solidly in twenty-four hours. Hiss's serum inulin medium is reddened and coagulated.

The organism dissolves readily in the presence of a solution of sodium taurocholate. If several drops of a 2 per cent. solution of sodium taurocholate are added to two cubic centimeters of a twenty-four hour growth in bouillon, the mixture rapidly becomes clear, provided there is no trace of blood serum present.

Pneumococcus mucosus is highly pathogenic for white mice and rabbits. One millionth of a cubic centimeter of an eighteen hour bouillon culture will kill a mouse in from fifteen to twenty-four hours when injected intraperitoneally. Its pathogenicity does not seem to be lessened by prolonged cultivation upon artificial media.

SPECIFIC AGGLUTINATION OF PNEUMOCOCCUS MUCOSUS.

It has been found by Dochez and Gillespie (4) that, by means of immunological reactions (agglutination and protection), the various strains of pneumococci recovered from the sputum and blood of patients with lobar pneumonia can be classified into at least three groups, with a fourth, less well defined group comprising organisms showing no interrelations. Their results demonstrate beyond question the heterogeneous character of the group of organisms possessing the physical and cultural properties of the pneumococcus. The macroscopic agglutination method was employed by Dochez, equal quantities of immune serum and twenty-four hour bouillon culture being used in the reaction. The results obtained were clean cut and definite, and were fully confirmed in each instance by the results of protection experiments, so that notwithstanding the low serum dilution employed, the method yielded specific information.

This method was therefore employed in attempting to demonstrate specific agglutinins for *Pneumococcus mucosus* in the serum of rabbits highly immunized to this organism. My results were uniformly negative. Two possibilities presented themselves. Either *Pneumococcus mucosus* was incapable of stimulating specific agglutinins, or else the method employed for their detection was inadequate. The first possibility seemed unlikely, since rabbits could be brought to a high state of active immunity to *Pneumococcus mucosus,*—higher indeed than rabbits immunized to other types of pneumococci and yielding good, specifically agglutinating sera.

A distinct analogy seemed to exist between the problem here presented and that of the specific agglutination of encapsulated bacilli; for the heavy mucoid capsule of *Pneumococcus mucosus* is its most strikingly distinguishing feature when compared with other pneumococci. The work of Porges (5) and von Eisler and Porges (6) has demonstrated that, contrary to the experience of previous workers, the capsule bacilli can be agglutinated readily by homologous immune sera, provided the bacilli are subjected previously to a preparatory treatment directed toward the destruction of their capsules.

The procedure recommended for this purpose by Porges has been employed with excellent results in the present attempt to demonstrate specific agglutinins in animals immunized to *Pneumococcus mucosus*. The method of Porges, as adapted to the present study, is as follows: Half a liter of a twenty-four hour bouillon culture of *Pneumococcus mucosus* was centrifugalized at high speed for half an hour, the supernatant fluid decanted off, and the organisms taken up in ten cubic centimeters of salt solution. Three cubic centimeters of this emulsion were added to each of three test-tubes and one cubic centimeter (one fourth volume) of N/4 hydrochloric acid was added to each. The tubes were placed in a water bath at 80° C., and one was removed in twenty minutes, the second in thirty, and the third in fifty minutes. They were placed immediately in ice water, and when thoroughly cooled one cubic centimeter of N/4 sodium hydrate was added to each tube. The emulsions thus prepared are neutral, they show no tendency toward spontaneous agglutination, and sedimentation takes place very slowly.

The six *Pneumococcus mucosus* organisms were treated after this fashion and the agglutinability of each was tested with the sera of six rabbits, each of which had been immunized to one of these organisms. The results are shown in table II.

TABLE II.

Agglutination (Porges Method).

Organism No.	Immune sera.										Normal rabbit serum.
	19	26	42	54	68	96	I	II	49	174	
19	+	+	+	+	+	+	−	−	−	−	−
26	+	+	+	+	+	+	−	−	−	−	−
42	+	+	+	+	+	+	−	−	−	−	−
54	+	+	+	+	+	+	−	−	−	−	−
68	+	+	+	+	+	+	−	−	−	−	−
96	+	+	+	+	+	+	−	−	−	−	−
I	−	−	−	−	−	−	+	−	−	−	−
II	−	−	−	−	−	−	−	+	−	−	−

In every instance the treated organisms agglutinated, whereas twenty-four hour bouillon cultures of the same organisms constantly failed to agglutinate. Equal quantities of immune serum and emulsion were used, and the tubes were kept at 37° C. during the experiment. Agglutination appeared promptly as a rule, and readings

made at the end of one hour were usually positive; final readings were made after six hours. The end result is quite definite, the supernatant fluid being clear, with the organisms forming a loosely coherent mass at the bottom of the tube. Of the three tubes of emulsion which were heated for varying lengths of time, the one treated for fifty minutes agglutinated slightly better than the others. As controls, emulsions of two other pneumococci (Nos. I and II) were made as described above, and these were likewise treated with the six *Pneumococcus mucosus* sera and with their own specific immune sera. They failed to agglutinate with the former, although with its own specific serum each agglutinated promptly. The emulsions of *Pneumococcus mucosus* were in no case agglutinated by sera other than their own, and remained well suspended in normal sera.

These reactions leave no room for doubt that the method of Porges is efficacious in rendering *Pneumococcus mucosus* specifically agglutinable. This result is probably though not certainly attributable to the destruction of the heavy, mucoid capsules of the organisms. It is conceivable that other factors play a part but, at any rate, it can easily be demonstrated that the capsules have almost if not quite disappeared during the treatment.

COMPLEMENT FIXATION EXPERIMENTS.

It is desirable to learn not only the relations of *Pneumococcus mucosus* to other pneumococci, but to the streptococcus group as well. Agglutination experiments demonstrated clearly the presence of specific agglutinins in the sera of rabbits immunized with *Pneumococcus mucosus,* but since the method employed is inapplicable to the streptococci, owing to their marked tendency toward spontaneous clumping and sedimentation, it throws no light upon a possible relationship of *Pneumococcus mucosus* to the streptococcus group.

The complement fixation method of Bordet-Gengou seemed much better adapted to this purpose and was therefore used with the results detailed below. The slightly modified Wassermann technique, as described by Walker and Swift (7), was employed.

Antigens.—Antigens with strong fixing power and weak anticomplementary action are readily obtained with *Pneumococcus*

mucosus (8). Twenty-four hour bouillon cultures are thoroughly centrifuged, the organisms washed once in normal salt solution, this removed as completely as possible, and the residue dried *in vacuo* over sulphuric acid. The dried substance is now weighed, one cubic centimeter of salt solution containing 0.5 per cent. phenol is added for each milligram of the dried material, and the whole is shaken for twenty-four hours in a bottle containing glass beads. The resulting emulsion is centrifugalized at high speed and the clear or slightly opalescent supernatant fluid is pipetted into rubber-corked brown bottles and kept in the ice box. Under these conditions the antigens have shown no deterioration after more than three months.

Antigens were prepared from each of the six strains of *Pneumococcus mucosus* and from pneumococcus I and II. In addition, antigens were made in a similar fashion from the *Streptococcus mucosus* and *Streptococcus pyogenes* previously described.

Immune Sera.—Rabbits were immunized to all the various organisms mentioned above. *Pneumococcus mucosus* is highly pathogenic for rabbits and, to avoid losses, the greatest care is necessary in rendering them immune to it. It frequently happens that rabbits succumb to a dose only slightly larger than the previous one, even after weeks of treatment with carefully graded doses of the organism. With care, however, quite high degrees of active immunity can be obtained, so that animals will show no serious reaction after an intravenous injection of the bacteria from 100 cubic centimeters of twenty-four hour bouillon culture. When we recall that 0.000001 of a cubic centimeter will kill, this degree of immunity is seen to be considerable. Organisms should always be centrifugalized free from the bouillon medium, for it is harmful when injected repeatedly. It has been found best to give an initial injection of killed organisms from 30 to 50 cubic centimeters of bouillon, and then to use live organisms for the next injection, beginning with very small doses and increasing as rapidly as the animal's condition permits. It is desirable that the animals should react severely to the injections; those animals in my series which have shown high fever and considerable loss of weight have furnished the most powerful sera.

Guinea pig complement, sheep cells, and anti-sheep cell rabbit serum were employed as a hemolytic system.

The results of the complement fixation experiments are illustrated by the tables III to X, which have been selected as typical. The various immune sera were first tested against constant quantities (0.1 of a cubic centimeter) of the different antigens, the sera being progressively diluted, and then against diminishing quantities of antigens, 0.1 of a cubic centimeter of serum being used.

The amount of antigen used was never greater than one fifth of the anticomplementary dose. The uniformity in the strength of antigens prepared from the six strains of *Pneumococcus mucosus* has been striking. As an antigen, any one of them could be chosen as representative of the group.

Specifically fixing sera have been obtained, as a rule, without great difficulty. It has been easier to obtain sera with high fixing powers by immunizing with *Pneumococcus mucosus* than with the other types of organisms used. This may be due in part to the severe reactions which the *Pneumococcus mucosus* animals showed to the earlier injections.

TABLE III.

Serum 26 in Diminishing Quantities with Constant Amount (0.1 Cubic Centimeter) of Antigen.

Antigen No.	0.005 c.c.	0.0025 c.c.	0.0012 c.c.	0.0006 c.c.	0.0003 c.c.
26 (0.1 c.c.)	+++	+++	+++	++	+
42 (0.1 c.c.)	+++	+++	++	+	
96 (0.1 c.c.)	+++	+++	++	+	−
I (0.1 c.c.)	+	+	−	−	−
II (0.1 c.c.)	+	±	−	−	−
49 (0.1 c.c.)	−	−	−	−	−
174 (0.1 c.c.)	−	−	−	−	−

TABLE IV.

Serum 68 in Diminishing Quantities with Constant Amount (0.1 Cubic Centimeter) of Antigen.

Antigen No.	0.005 c.c.	0.0025 c.c.	0.0012 c.c.	0.0006 c.c.	0.0003 c.c.
68 (0.1 c.c.)	+++	+++	++	+	+
19 (0.1 c.c.)	++	++	±	−	−
26 (0.1 c.c.)	+++	+++	++	+	−
42 (0.1 c.c.)	+++	+++	++	+	±
54 (0.1 c.c.)	+++	+++	++	+	−
96 (0.1 c.c.)	+++	+++	++	++	+
I (0.1 c.c.)	++	+	−	−	−
II (0.1 c.c.)	+	±	−	−	−
49 (0.1 c.c.)	−	−	−	−	−
174 (0.1 c.c.)	−	−	−	−	−

TABLE V.

Serum 96 in Diminishing Quantities with Constant Amount (0.1 Cubic Centimeter) of Antigen.

Antigen No.	0.005 c.c.	0.0025 c.c.	0.0012 c.c.	0.0006 c.c.	0.0003 c.c.
96 (0.1 c.c.)	+++	+++	+++	+++	+++
19 (0.1 c.c.)	+++	+++	++	+±	−
26 (0.1 c.c.)	+++	+++	+++	+++	+++
42 (0.1 c.c.)	+++	+++	+++	+++	++
54 (0.1 c.c.)	+++	+++	+++	+++	++
68 (0.1 c.c.)	+++	+++	++	+	+
I (0.1 c.c.)	++	++	−	−	−
II (0.1 c.c.)	+	±	−	−	−
49 (0.1 c.c.)	−	−	−	−	−
174 (0.1 c.c.)	−	−	−	−	−

TABLE VI.

Serum I in Diminishing Quantities with Constant Amount (0.1 Cubic Centimeter) of Antigen.

Antigen No.	0.05 c.c.	0.01 c.c.	0.005 c.c.	0.0025 c.c.
I	+++	+++	++	+
II	+	+	−	−
19	++	++	+	−
26	+++	++	+	−
42	+++	+++	++	+
68	++	++	+	−
96	+++	+++	++	−
49	−	−	−	−
174	−	−	−	−

TABLE VII.

Serum II in Diminishing Quantities with Constant Amount (0.1 Cubic Centimeter) of Antigen.

Antigen No.	0.05 c.c.	0.01 c.c.	0.005 c.c.	0.0025 c.c.
II (0.1 c.c.)	+++	++	+	−
I (0.1 c.c.)	++	+	−	−
19 (0.1 c.c.)	++	+	−	−
26 (0.1 c.c.)	++	+	−	−
42 (0.1 c.c.)	++	++	−	−
68 (0.1 c.c.)	++	+	−	−
96 (0.1 c.c.)	++	+	−	−
49 (0.1 c.c.)	−	−	−	−
174 (0.1 c.c.)	−	−	−	−

TABLE VIII.

Serum 26, 0.1 Cubic Centimeter, with Decreasing Amounts of Antigen.

Antigen No.	0.05 c.c.	0.04 c.c.	0.03 c.c.	0.02 c.c.	0.01 c.c.
26	+++	+++	+++	++	−
19	+++	++	+	±	−
42	+++	+++	++	+	+
54	+++	+++	++	+	−
68	+++	+++	+++	+	−
96	+++	++	++	+	−
I	++	+	−	−	−
II	+	−	−	−	−

TABLE IX.

Serum 42, 0.1 Cubic Centimeter, with Decreasing Amounts of Antigen.

Antigen No.	0.05 c.c.	0.04 c.c.	0.03 c.c.	0.02 c.c.	0.01 c.c.
42	+++	+++	++	+	+
19	++	++	+	−	−
26	+++	+++	++	+	−
54	+++	+++	+	±	−
68	+++	+++	++	+	+
96	+++	+++	++	+	−
I	++	++	−	−	−
II	+	−	−	−	−

TABLE X.

Serum 96, 0.1 Cubic Centimeter, with Decreasing Amounts of Antigen.

Antigen No.	0.05 c.c.	0.04 c.c.	0.03 c.c.	0.02 c.c.	0.01 c.c.
96	+++	+++	+++	++	+
19	+++	+++	++	+	−
26	+++	+++	+++	++	+
42	+++	+++	+++	++	+
68	+++	+++	+++	++	+
I	++	++	++	+	−
II	+	+	−	−	−

As shown in the tables, there has been a certain amount of cross-fixation, or group reaction, among the pneumococci. This group reaction is most clearly demonstrated by using immune sera I and II with *Pneumococcus mucosus* antigens (tables VI and VII). Antigen I has constantly reacted more strongly with *Pneumococcus mucosus* sera than has antigen II. There can be no doubt that, as shown by Dochez, these two organisms are essentially different; they likewise differ in essential points from *Pneumococcus mucosus.*

No cross-fixation was observed in testing the complement-fixing

powers of sera 49 (*Streptococcus mucosus*) and 174 (*Streptococcus pyogenes*). They each fixed specifically with homologous antigens, but showed no fixation with heterologous antigens.

From the foregoing considerations, the conclusion is justifiable that Schottmüller's *Streptococcus mucosus* is in reality a variety of pneumococcus. Its cultural characteristics, solubility in solutions of bile salts, and finally its behavior in comparative complement fixation experiments all support this conclusion.

PROTECTION EXPERIMENTS.

The homogeneous character of the *Pneumococcus mucosus* group would, of course, be a most fortunate condition if an antiserum capable of conferring passive immunity could be produced. To determine the possibility of obtaining such a serum has been one of the aims of this study. A high grade of active immunity to *Pneumococcus mucosus* has been produced in rabbits, and the antisera obtained have been used in attempting to protect white mice against this organism. Immune serum and the bouillon culture of the organism were injected simultaneously into the peritoneal cavity. The most favorable result obtained is shown in the following protocol:

Organism 42.	Antiserum 42.	
0.000001 c.c.	0.5 c.c.	Dead in 60 hours.
0.00001 c.c.	0.5 c.c.	Dead in 35 hours.
0.0001 c.c.	0.5 c.c.	Dead in 18 hours.
Control.		
0.000001 c.c.		Dead in 18 hours.
0.00001 c.c.		Dead in 15 hours.
0.0001 c.c.		Dead in 14 hours.

A slight prolongation of life would seem to have resulted from the use of 0.5 of a cubic centimeter of antiserum, but this result has not been constant with all the sera employed. As a rule the experimental animals and the controls have died within approximately the same lengths of time.

We are confronted, then, with the curious fact that the sera of animals possessing a high degree of active immunity fail to confer passive immunity to homologous organisms upon other animals.

This result is the more surprising because of the relative ease with which protecting antisera can be obtained with other strains of pneumococci. For example, rabbits which have received ten cubic centimeters of a twenty-four hour bouillon culture of pneumococcus I as the maximum immunizing dose, furnish sera which will protect against 0.1 of a cubic centimeter of this organism, whereas the sera of rabbits which have received 100 cubic centimeters of *Pneumococcus mucosus* as a maximum dose fail to protect mice against 0.000001 of a cubic centimeter of the homologous organism. These facts indicate the existence of fundamental differences between *Pneumococcus mucosus* and other varieties of pneumococci, and it is of great interest to inquire into the causes which may possibly underlie these differences.

The failure of *Pneumococcus mucosus* antisera to protect is due in all probability to some peculiarity in the constitution of this organism rendering it extremely resistant to the action of specific antisera, and one naturally thinks first of the heavy mucoid capsule. It is instructive to recall in this connection certain facts which have come to light in the study of the encapsulated bacteria. With these organisms, as with *Pneumococcus mucosus,* no protection has been obtained, although active immunity is produced without difficulty (9). Porges (5) cites an interesting observation upon *Bacillus pneumoniæ* of Friedländer. A strain of this organism which had been cultivated for a long period upon artificial media showed no capsule formation and could be agglutinated without previous treatment. It thus seemed a very favorable organism with which to test for specific protection, but when injected into animals together with specific antiserum, no protection was afforded and it was found that the organisms had developed capsules in the animal body. The somewhat similar experiences of Gruber (10) and Löhlein (11) with anthrax and plague bacilli likewise seem to indicate that the serum resistance of certain organisms may be due to capsule formation. As to the correctness of this, judgment must be suspended until more facts are at hand. The problem seems worthy of more careful study than it has as yet received.

Lobar pneumonia caused by *Pneumococcus mucosus* has been in the experience of this hospital a very fatal disease, six of our nine

cases (66 per cent.) having died. The organism was cultivated from the blood in four of the nine cases and none of these recovered.

CONCLUSIONS.

1. The organisms described by Schottmüller under the name *Streptococcus mucosus* represent a well defined group with characteristics which indicate a closer relationship to the pneumococci than to the streptococci.

2. The members of this group are specifically agglutinable when treated according to the method of Porges. They do not agglutinate when subjected to the usual agglutination methods.

3. Complement fixation experiments with these organisms, compared with similar experiments with two varieties of pneumococci and two streptococci, indicate that they are closely related to the pneumococci.

4. No protection of mice against *Pneumococcus mucosus* by means of specific immune sera could be demonstrated.

5. The name *Pneumococcus mucosus* should be adopted for this group instead of *Streptococcus mucosus.*

BIBLIOGRAPHY.

1. von Lingelsheim, W., in Kolle-Wassermann, Handbuch der pathogenen Mikroorganismen, Jena, 1912, iv, 495.
2. Schottmüller, H., *München. med. Wchnschr.,* 1903, l, 849; 1905, lii, 1425.
3. Neufeld, F., and Händel, L., in Kolle-Wassermann, Handbuch der pathogenen Mikroorganismen, Jena, 1912, iv, 513.
4. Dochez, A. R., and Gillespie, L. J., *Jour. Am. Med. Assn.,* 1913, lxi, 727.
5. Porges, O., *Wien. klin. Wchnschr.,* 1905, xviii, 691.
6. von Eisler, M., and Porges, O., *Centralbl. f. Bakteriol., 1te Abt., Orig.,* 1906, xlii, 660.
7. Walker, I. C., and Swift, H. F., *Jour. Exper. Med.,* 1913, xviii, 75.
8. Swift, H. F., and Thro, W. C., *Arch. Int. Med.,* 1911, vii, 24.
9. Abel, R., and Hallwachs, W., in Kolle-Wassermann, Handbuch der pathogenen Mikroorganismen, Jena, 1913, vi, 528.
10. Gruber, *Centralbl. f. Bakteriol., 1te Abt., Ref.,* 1906, xxxviii, Supplement, 11.
11. Löhlein, *Centralbl. f. Bakteriol., 1te Abt., Ref.,* 1906, xxxviii, Supplement, 32.