THE OCCURRENCE OF BACTERIUM PNEUMONIAE IN THE SALIVA OF HEALTHY INDIVIDUALS.*

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INTRODUCTION.

It is generally recognized that *Bacterium pneumoniae*† is found in the saliva of a considerable proportion of healthy individuals. The statement is frequently made that it occurs in one out of every five persons. But the experiments upon which these conclusions are based have been made by different observers at various times of the year and under a variety of conditions; so much so that it seemed worth while to restudy this question and to determine independently the distribution of this germ in the saliva. The salivas of some 50 individuals have been examined, and in some cases that of the same individuals at different times of the year. This was done to determine whether or not there was any variation in the seasonal distribution of the germ. The results seem to show that there is marked variation in the distribution of this germ at different seasons of the year. Other examinations have been made upon different classes of individuals at the same season of the year to note if any variation occurred which could be properly assigned to differences of occupation. Here again a variation appeared, especially when the distribution of the germ in the saliva of those employed "indoors" was compared with the distribution of the germ in the saliva of those employed "out of doors." The authors are well aware that the conclusions which might be drawn from these experiments are not conclusive, but it is believed that the results obtained are of sufficient import to warrant a somewhat detailed account of the experiments and the data collected.

*The work here described formed the basis for theses which were presented for the bachelor's degree at the University of Wisconsin, by Mr. (now Dr.) Divine in 1900 and by Mr. Reineking in 1904.

†Throughout this paper the term *Bacterium pneumoniae* is used instead of the more common term of "pneumococcus." This is in accordance with Migula's system of classification, which seems to be the one most widely accepted.

METHODS EMPLOYED.

The presence of *Bacterium pneumoniae* has been determined exclusively by the inoculation of rabbits with the saliva. The inoculations have been made as soon as possible after collection. The rabbits received approximately two c.c. intraperitoneally. In cases where the animals died the autopsies were performed as soon as possible. Cover-slips of the blood from the various organs were stained by means of the Welch capsule stain. Cultures were also made from the various organs. At first these were made on blood agar prepared according to the method recommended by Eyre and Washburn.¹ In this case the identification of *Bacterium pneumoniae* was confirmed by the appearance on this agar of small pinhead colonies. Later cultures were made directly into milk. In this medium the organism in question produces a thick curd and cover-slip preparations therefrom show beautiful capsules with the capsule stain. Those cases only were counted as positive in which there developed a septicemia and in which there was found in the blood of the rabbit, or milk subcultures therefrom, a lancet shaped diplobacillus and on which a definitely stained capsule could be demonstrated. In a few cases in order to economize on rabbits the saliva of several individuals, which seemed unlikely to contain the germ, were mixed and the mixture inoculated into a single rabbit. In case the rabbit died it was necessary to retest the saliva of each individual separately; but if the animal remained well it was taken for granted that none of the group contained the organism in question.

EXPERIMENTAL WORK.

From Table 1, which gives the details of the work, it is seen that there have been 85 inoculations. Thirty-two of these gave a positive result, or 37.6 per cent. The saliva was obtained from 50 different individuals. Eighteen of these showed the presence of this germ, or 36 per cent. The percentage of positive results obtained is higher than that reported by previous observers.

Of the 50 individuals tested 26 were university students, 2 were high school children, 6 were ward school children, 5 were teamsters, 5 were outside laborers (carpenters), 5 were draftsmen and 1 was a housewife. All were well at the time the saliva was collected and it is not known that any of them fell sick for some-time afterward, so that they may fairly be considered to have been healthy at the time their saliva was examined.

SEASONAL DISTRIBUTION.

A considerable part of the inoculations were undertaken, as already indicated, for the purpose of determining whether or not

TABLE 1.
INOCULATION OF RABBITS WITH THE SALIVA OF HEALTHY INDIVIDUALS.

NO. OF EXPERI- MENT	INDI- VIDUAL	TIME OF INOCULA- TION	RESULT		NO. OF EXPERI- MENT	INDI- VIDUAL	TIME OF INOCULA- TION	RESULT	
			Neg.	Pos.				Neg.	Pos.
1.....	A1	Oct.-Nov.	0		44.....	C5	Jan.-Feb.	0	
2.....	A2	"	0		45.....	D1	"		+
3.....	A3	"		+	46.....	D2	"	0	
4.....	A4	"	0		47.....	D3	"	0	
5A.....	A5	"	0		48.....	E1	"	0	
6.....	B1	"	0		49.....	E2	"		+
7.....	B2	"		+	50.....	E3	"	0	
8.....	B3	"	0		51.....	E4	"	0	
9.....	B4	"		+	52.....	E5	"		+
10.....	C1	"	0		53.....	F1	"	0	
11.....	C2	"	0		54.....	F2	"	0	
12.....	C3	"	0		55.....	F3	"	0	
13.....	C4	"	0		56.....	F4	"	0	
14.....	C5	"	0		57.....	G1	"		+
15.....	D1	"	0		58.....	G2	"	0	
16.....	D2	"	0		59.....	G3	"		+
17.....	D3	"	0		60.....	G4	"		+
18.....	E1	"	0		61.....	H1	"		+
19.....	E2	"	0		62.....	H2	"		+
20.....	E3	"	0		63.....	H3	"		+
21.....	E4	"	0		64.....	H4	"	0	
22.....	E5	"	0		65.....	H5	"	0	
23.....	F1	"	0		66.....	I1	Mch.-Apr.		+
24.....	F2	"	0		67.....	I2	"	0	
25.....	F3	"		+	68.....	I3	"	0	
26.....	F4	"		+	69.....	I4	"		+
27.....	G1	"		+	70.....	I5	"	0	
28.....	G2	"	0		71.....	J1	"	0	
29.....	G3	"		+	72.....	J2	"		+
30.....	G4	"	0		73.....	J3	"		+
31.....	A1	Jan.-Feb.		+	74.....	J4	"	0	
32.....	A2	"		+	75.....	J5	"		+
33.....	A3	"		+	76.....	K1	"	0	
34.....	A4	"	0		77.....	K2	"	0	
35.....	A5	"	0		78.....	K3	"	0	
36.....	B1	"		+	79.....	K4	"	0	
37.....	B2	"	0		80.....	K5	"	0	
38.....	B3	"		+	81.....	L1	"		+
39.....	B4	"		+	82.....	L2	"		+
40.....	C1	"	0		83.....	L3	"		+
41.....	C2	"	0		84.....	L4	"		+
42.....	C3	"	0		85.....	L5	"		+
43.....	C4	"	0						

the season of the year had any influence on the prevalence of the germ in the saliva. On account of the large number of rabbits required periods were selected about two months apart. In the year 1900 the saliva of 30 individuals was examined in the fall and then again in the winter months. The figures given for the spring months were obtained in 1904 and from an entirely different set of people. While the results obtained then in the first and second periods are directly comparable, the results obtained for the spring months can not be so closely compared with the preceding. The results obtained show that of the 30 examina-

tions made in the fall 7 were positive, or approximately 24 per cent; that of the 35 inoculations made in the winter 15, or 43 per cent, were positive; and that of the 20 inoculations in the spring 10, or 50 per cent, were positive.

VIRULENCE OF THE GERM.

Another question of considerable importance is that of the virulence of the germ of pneumonia as it occurs in the saliva. This has been judged entirely by the period elapsing between the time of inoculation and the death of the rabbits. This time has varied from 20 to 100 hours. The details are represented graphically in Fig. 1.

FIG. 1.—Virulence of *Bacterium pneumoniae* as indicated by the course of the disease in rabbits. The ordinates represent the per cent of rabbits which died at or within a given time. The abscissae are the intervals expressed in hours.

It would thus appear that the virulence of this germ was greater during the time when it was most prevalent and lower when it was less common. In other words it appears that 90 per cent of the rabbits died within 24 hours in the spring, about 73 per cent in the winter, and only about 42 per cent in the fall months.

PERSISTENCE OF THE GERM IN THE SALIVA.

Still another point of some interest is the question as to whether or not the germ persists in the same throat for sometime. The condition of affairs as it appeared in this work is shown in the following table:

TABLE 2.
PERSISTENCE OF THE PNEUMONIA GERM IN THE SAME THROAT AT DIFFERENT SEASONS
OF THE YEAR.

	GROUP														
	A1	A2	A3	B1	B2	B3	B4	D1	E2	E3	F3	F4	G1	G3	G4
Fall	-	-	+	-	+	-	+	-	-	-	+	+	+	+	-
Winter	+	+	+	+	-	+	+	+	+	+	-	-	+	+	+

It is seen here that of the 7 individuals whose saliva contained *Bacterium pneumoniae* in the fall only 4 contained it in the winter months, and that of the 12 individuals who harbored it in the winter 8 had acquired it since the previous examination. Or again only 4 out of the 15 gave the same reaction at both examinations.

INFLUENCE OF OCCUPATION.

In regard to the influence of occupation on the presence of this germ in saliva but little can be determined from the earlier experiments (Nos. 1 to 60) since they were not performed with this idea in view and all of the subjects were selected from practically the same occupation; but the latter experiments (Nos. 61 to 85) bear directly on this subject. In this part of the work three classes were studied: those who were indoors almost entirely, those in and out, and those who worked outside all day. For convenience they were divided into groups. Group L consisted of five draftsmen, working in a machine shop. Groups H and I were five university students. The group designated J were teamsters or hack drivers who worked outside a great deal but not constantly. The last group (K) was composed of five laborers who worked out of doors all day all of the year around as carpenters.

TABLE 3.
INFLUENCE OF OCCUPATION ON THE DISTRIBUTION OF THE PNEUMONIA GERM IN SALIVA.

Group	No. of Indi- viduals Tested	Occupation	No. of Indi- viduals Reacting	Per Cent Reacting
K.....	5	Laborers	0	0
J.....	5	Teamsters	2	40
I.....	5	Students	2	40
H.....	5	Students	3	60
L.....	5	Draftsmen	5	100

These results suggest that occupation may be a factor in accounting for the variation of the distribution of this germ in the saliva of healthy individuals.

SUMMARY.

Eighty-five rabbits have been inoculated with saliva causing sputum septicemia in 32 or 37.6 per cent.

The saliva of 50 different individuals has been examined and in 18 or 36 per cent of the cases *Bacterium pneumoniae* has been found.

The frequency with which this germ appears seems to vary with the season of the year, 23 per cent of the salivas examined in the fall being positive, 43 per cent in the winter and 50 per cent in the spring.

The virulence* of the germ, as indicated by the rapidity of the course of the disease in the rabbit, varies, the greatest virulence appearing during the period of greatest frequency.

The germ may persist in the saliva of certain individuals from season to season but more than 66 per cent of the cases positive in winter were negative in the fall.

Bacterium pneumoniae appears to be more frequent in the saliva of individuals working "indoors" than those working "outdoors."

*No account is taken of the number of germs that might be present.