BACTERIOLOGICAL AND CLINICAL ASPECTS OF INFECTION OF THE ACCESSORY SINUSES OF THE NOSE.*

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This investigation was undertaken at the suggestion of Dr. C. G. Coakley, not as an inquiry into a previously unexplored province, but in an attempt to correlate the bacteriological findings with the clinical types of sinusitis, and if possible give aid in making an early prognosis, and in selecting an appropriate form of treatment.

The material used consisted of the muco-pus obtained from one hundred cases, with infected sinus or sinuses treated in the private practice of Dr. Coakley. The cases are consecutive except for the omission of a few cases seen in consultation and not afterwards, rendering it impossible to get the desired data in respect to their subsequent history. The bacteriological work was done in the laboratories of the Department of Bacteriology, College of Physicians and Surgeons, Columbia University, through the courtesy of Professor Hans Zinsser and Dr. A. K. Balls, for whose valuable suggestions and aid, grateful acknowledgment is hereby made. Acknowledgment is also made of the kindness of the Rockefeller Institute in furnishing immune pneumococcus serum.

In the majority of cases, the secretion was caught in a sterile test tube as it came from the nose while the sinus was being irrigated with a sterile solution of salt and bicarbonate of soda, the nose in all cases being previously irrigated. In a few cases the secretion could be directly aspirated and collected under strictly sterile conditions. Ethmoid cultures were made directly. The material was planted on the day of collection on bouillon, glucose-agar and blood-agar, after first attempting to overcome any possible contamination of the surface of the masses of muco-pus by several washings in sterile saline or, as was done in the later cases, by streaking it over an agar plate and taking the last of the streak for culture. Some changes were made in the routine as the work advanced. Bouillon was discarded as a primary culture medium, and anaerobic cultures were made in those cases in which a foul odor was present.

Smears of the muco-pus were made as a routine and stained with Hastings' stain, to give an idea of the cytology of the secre-

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tion as well as to determine the presence of bacteria. The bacterial findings in the smears very closely agreed with the subsequent findings on culture, except that a fairly large proportion of cases showing no bacteria on smears grew various organisms. Only two out of five cases in which no growth occurred, showed bacteria on smear. In one case these were long paired cocci, undoubtedly pneumococci, and in other a bacillus which was not identified.

The cytological findings showed nothing of great interest except to roughly confirm the findings of Darling,¹ who found that the presence of an excess of lymphocytes, especially when coupled with the presence of streptococci, renders the chance of cure without a radical operation distinctly less. One interesting finding was the occasional presence of a large proportion of eosinophiles, without any uniform clinical or bacterial relationship.

In considering the actual bacterial findings in the material from the sinuses, we must admit the possibility, in the majority of cases, of contamination in the specimen's passage through the nose. All the precautions thought possible were taken, but there is still some room for question. Results, however, seem to show little, if any contamination, as 69 out of 119 cultures showed only one organism or no growth. The normal nose is not usually sterile, but such organisms as streptococci and pneumococci are rarely found, according to Park and Wright.² The accessory sinuses are, on the contrary, found sterile in health, according to Skillern³ and Turner and Lewis.⁴ With a thorough washing of the nose as a preliminary to obtaining the cultures, the chance of contamination seems small.

The cases were rather arbitrarily divided into acute and chronic classes, depending upon the duration of the attack. Attacks lasting one month or less are called acute, and the others chronic. It is often difficult to learn the exact duration of infection in a sinus. In this series, two cases were classed as acute, although lasting five weeks, if one may judge from the history given. This was done because of their behavior under treatment, four days in case 66, and seventeen days in case 78 of irrigation of the antrum involved sufficing to clear them up. In the chronic cases especially, the duration of the attack is difficult to determine, "years" being a favorite term given. Such indefinite periods have been omitted in computing the average duration of attacks.

Of the one hundred cases, fifty-three were acute, forty having one, twelve having two and one having three sinuses involved.

These consist of involvement of the right antrum 28 the left antrum 30, the right frontal 2, the left frontal 2, the right sphenoid 3, the left sphenoid 1 and the right ethmoid 1 times, making sixty-seven cavities involved. This does not include ethmoidal involvement occurring with antrum. The following combinations occurred: Right and left antrum 9; right antrum and right sphenoid 1; left antrum and left frontal 1; right antrum and right frontal 1; and the right and left antrum and left sphenoid 1. Single cavities were involved as follows: Left antrum 19, right antrum 16, left frontal 1, right frontal 1, right sphenoid 2 and right ethmoid 1 times.

Forty-seven cases were classed as chronic, thirty-four having 1, six having 2, two having 3, three having 4 and two having 5 sinuses involved. The right antrum was involved in 21 cases, the left antrum in 30, the right frontal in 5, the left frontal in 4, the right sphenoid in 3, the left sphenoid in 7 and the right ethmoid in 2 cases. This list also omits some ethmoiditis associated with maxillary sinusitis. Single sinuses were involved as follows: Right antrum 10, left antrum 19, right frontal 2, and left sphenoid 3 times. Combination of two sinuses occurred as follows: Right and left antrum 4, right ethmoid and right sphenoid 1, and right antrum and right ethmoid 1 times. Combinations of three were chronic right and left sphenoids with an acute left antrum once, right and left antrum with left frontal once. Combinations of four were right and left antrum with right ethmoid and sphenoid once; right and left antrum with right and left frontal once, and right antrum with left antrum, frontal and sphenoid once. The following combination of five occurred twice: Right and left antrum, right and left frontal and left sphenoid.

The sexes occurred as follows: Male, 28 acute and 23 chronic cases. Female, 25 acute and 24 chronic cases. No especial susceptibility of either sex is apparent.

The ages of the patients were arranged in decades. In the acute cases one case occurred in the first decade, three in the second, twelve in the third, nineteen in the fourth, eleven in the fifth, five in the sixth, and two in the seventh. The youngest patient was five and the oldest sixty-five years. The average age was 36 years. In the chronic cases, three occurred in the second decade, nine in the third, eleven in the fourth, eighteen in the fifth, five in the sixth and one in the seventh. The youngest patient was 13 and the oldest 60 years. The average age was 38 years. The difference is so slight that no conclusion seems warranted.

In the acute cases the following bacteria have been found:

PNEUMOCOCCUS

Type not determined.....	5	
Group II	9	
Group III	3	
Group IV	15	Total 32

STREPTOCOCCUS

Hemolytic	3	
Non-hemolytic	2	Total 5

STAPHYLOCOCCUS

Aureus	13	
Albus	17	Total 30

B. Influenza 4

M. Catarrhalis 2

A Diphtheroid Bacillus 2

B. Coli Communis 2

B. Fecalis Alkaligenes 3

B. Aureus 1

B. Proteus 3

B. Subtilis 1

No growth 4

This makes eleven different organisms occurring eighty-five times.

The chronic cases showed:

PNEUMOCOCCUS

Type not determined	1	
Group II	1	
Group IV	4	Total 6

STREPTOCOCCUS

Hemolytic	15	
Non-hemolytic	4	Total 19

STAPHYLOCOCCUS

Aureus	18	
Albus	20	Total 38

B. Influenza 2

B. Mucous Capsulatus 5

A Diphtheroid Bacillus 4

B. Coli Communis 2

B. Fecalis Alkaligenes 3

B. Aureus 3

B. Proteus 1

M. Tetrigenus 3

B. Subtilis 1

No growth 1

This makes thirteen different organisms occurring ninety times
Pure growth of one organism was found as follows:

ACUTE CASES

Pneumococcus	24
Streptococcus	2
Staphylococcus	10
B. Aureus	1
Diphtheroid Bacillus	1
M. Catarrhalis	1

CHRONIC CASES

Pneumococcus	3
Streptococcus	4
Staphylococcus	15
B. Mucosus Capsulatus	1
Diphtheroid Bacillus	1
M. Tetragenus	1

The combinations are so varied and their relation to clinical findings so indefinite, with one exception which will be referred to later, that a detailed list seems unwarranted. Two of the organisms found, namely *B. aureus* and *B. subtilis* seem harmless saprophytes and may well be only contaminations, but were found only six times in all. *B. coli communis*, *B. fecalis alkaligenes* and *B. proteus* seem of doubtful pathogenicity in the sinuses, and never occurred alone, so can be largely discounted as possible contaminants. The addition of a staphylococcus albus to another organism seems, however, to definitely prolong the time required for treatment in the chronic cases as will be shown. No great difference in the types of pneumococci was noted in the duration of the attacks except that Case 100 was treated longer than was usually necessary for the other types—(27 days), but Case 96, with the same Type III infection only required 4 and 6 days for her antrum to clear up. The secretion was similar in both cases of a rather clear mucoid character, and Case 100 looked, from the character of the washings, as if he should clear up long before he did so.

In view of these facts, it seems advisable, in attempting to correlate the bacteriological and clinical findings, to subdivide the acute cases somewhat after the manner of Turner and Lewis⁴ into pneumococcus, staphylococcus, streptococcus and miscellaneous groups. The chronic cases seem to warrant the above groups and an additional one in which *B. mucosus capsulatus* predominates, as that organism was only found in chronic cases.

The relationship between the bacterial groups, the duration of the disease, the time and kind of treatment and the results are as follows:

ACUTE CASES.

Pneumococcus Group 32

Time of attack, 5 to 35 days; average 11 days.

Time treated, 3 to 27 days; average $8\frac{3}{4}$ days.

All of the cases were cured by lavage of the sinuses involved and no operations for improving drainage were required.

Streptococcus Group 5

Time of attack, 5 to 24 days; average 14 days.

Time treated, 3 to 15 days; average 9 days.

Four cases were cured (80%) and the remaining case (No. 92) was much improved and left our hands to be treated in his home city. No operations were required.

Staphylococcus Group 22

Time of attack, 2 to 30 days; average 19 days.

Time treated, 2 to 19 days; average 9 days.

All the cases were cured. An operation, external incision and partial exenteration of right ethmoid was performed on Case 76, a child of 5 years, who had an extremely violent infection with orbital cellulitis.

Miscellaneous Group 3

(*B. aureus*, a diphtheroid bacillus and *M. catarrhalis*)

Time of attack, 9 to 35 days; average 18 days.

Time treated, 4 to 11 days; average 8 days.

All of the cases were cured and no operation required.

"No Growth" Group 4

Time of attack, 10 to 30 days; average 19 days.

Time treated, 6 to 12 days; average 9 days.

All of the cases were cured. No operations required.

The average time treated of all acute cases, associated with whatever organism is practically the same. The time of attack is somewhat shorter in the Streptococcus and Pneumococcus Groups.

CHRONIC CASES.

Pneumococcus Group 6

Time of attack, 2 mos. to 2 years; average $7\frac{1}{2}$ months.

Time treated, 6 days to 6 months; average 55 days.

Three were associated with staphylococcus albus and were treated on an average of 41 days, one being cured and two improved. Altogether three were cured (50%) and three improved. Two ($33\frac{1}{3}\%$) operations were performed, and polyps were present in one case (41) showing pneumococcus II, staphylococcus albus and micrococcus catarrhalis.

Streptococcus Group 19

Time of attack, 1 month to 13 years; average 43 months.

Time treated, 4 days to 5 months; average 48 days.

Seven cases were associated with *staphylococcus albus* and were treated on an average of 71 days. Sixteen were cured (84%) and three were improved, only one of these last being associated with *staphylococcus albus*. Polyps were present in one case (43), showing a non-hemolytic streptococcus and *B. mucosus capsulatus*. Eight (44%) operations were performed, by which seven were cured and one improved (Case 94), of five years' duration and treated three months.

Staphylococcus Group 21

Time of attack "months" to 20 years; average 11 years.

Time treated, 14 days to 4 years; average 171 days.

Thirteen cases (62%) were cured and eight improved. Nine (40%) operations were performed with five cures and four improvements (Cases 1-10-36 and 86).

B. Mucosus Capsulatus Group 3

Time of attacks "months" to 20 years; average 11 years.

Time treated, 13 to 98 days; average 43 days.

Two cases (66⅓%) were cured and one case (40) showing pure *B. mucosus capsulatus*, improved. No operations were performed.

Miscellaneous Group 3

(*B. Influenza*, *B. fecalis alkaligenes* and *B. aureus* together, a diphtheroid bacillus and *M. tetragenus*.)

Time of attack, 6 weeks to "years;" average 15 weeks.

Time treated, 3 days to 26 days; average 12 days.

All three cases were cured and no operations required.

"No Growth" Group 1

Time of attack, 1 year.

Time treated, 3 days.

Cured without operation.

The type of treatment was daily lavage through the natural orifice of the sinus involved, or in case of an antrum, through a puncture in the inferior meatus. An "operation" means a large opening between the sinus involved and the nasal cavity, except in the one instance of Case 76 where an external incision was made for acute ethmoiditis with orbital cellulitis.

Note was made of the relation between the infecting organisms of different sinuses involved in the same case. In the acute cases eight were investigated, of which six were approximately the same and two differed somewhat. They were as follows:

Pneumococcus IV—in right and left antra, three times.

Pneumococcus III—in right and left antra.

Pneumococcus IV—in right and left antra and left sphenoid with the addition of staphylococcus aureus and *B. subtilis* in the right antrum and right sphenoid, with the addition of *B. coli communis* in the right antrum.

Pneumococcus II, staphylococcus aureus and *M. catarrhalis* in the right antrum with staphylococcus aureus and *B. proteus* in the left antrum.

Micrococcus catarrhalis in the left antrum with "No Growth" in the right antrum.

In the chronic cases, 5 cases were investigated, 4 seeming to agree and one to disagree, as follows:

Streptococcus hemolytic and staphylococcus albus in right antrum and frontal.

Streptococcus hemolytic and staphylococcus aureus in left and right antra with the addition of a diphtheroid bacillus in the right antrum.

Staphylococcus albus in right antrum and ethmoid with addition of *M. catarrhalis* in the antrum.

Staphylococcus aureus in right and left antra and left frontal with addition of *B. mucosus capsulatus* in the left frontal.

Pneumococcus and staphylococcus albus in the left antrum with non-homolytic streptococcus and *M. catarrhalis* in the right antrum.

Of agreement between present cultures and those of former attacks in the same sinus, little could be found on account of the dearth of cultures of former attacks. Four cases were, however, investigated, one of which agreed and three disagreed as follows:

Right antrum—pneumococcus IV—in 1917—and pneumococcus in 1912.

Right antrum—streptococcus hemolyticus and staphylococcus albus in 1917, and a pneumococcus earlier in 1917, and by a different laboratory.

Left antrum—staphylococcus albus, *M. catarrhalis* and *B. fecalis alkaligenes* in 1917 and streptococcus in 1913.

Right antrum—pneumococcus II—in 1917 and staphylococcus albus and *B. proteus* eight months earlier in 1917.

Thirty-three other cases had had one or more previous attacks which were not cultured.

The pathway of infection of the involved sinuses was investigated and the findings do not agree with those of Turner and Lewis² who thought one-third of the cases of antrum infection were of dental origin. Of 109 infected antra only eight of (7½%) seemed to have any connection at all with infected tooth roots, and in none of them was any connection between the antrum and the

infected area established on removal of the tooth. However, it is admitted that the infection could pass from the tooth to the antrum without a gross connection.

The organisms found were staphylococcus 6 times, non-homolytic streptococcus, *B. coli communis* and *M. tetragenus*.

Several special antiseptics were used. Chlorazene 1-1000 and 1-100 (Case 47) and on two cases, not in this series, dichloramine T-2% (Cases 36 and 94) and ethyl-hydro-cuprein 1-1000 (Cases 61 and 100 each showing pneumococci) without any appreciable benefit being noted. In fact, the stronger solution of Chlorazene and in one case the dichloramine T, proved decidedly irritating. One of the commercial preparations of *B. lactis bulgaricus* was used on Case 1 for five successive days without any benefit being noted and a culture taken after a few days' interval did not show the presence of the therapeutic organism.

Attempts to determine the cause of the foul odor present in some cases reached no satisfactory conclusion. Nothing was obtained from anaerobic cultures which did not also grow aerobically. However, in one case a diphtheroid bacillus had a foul odor when grown without air, but not under aerobic conditions.

No other odoriferous bacteria were observed except those in the colon group. Turner and Lewis⁵ found a foetor due to the colon group and to some anaerobes, especially those connected with tooth decay. In this series no such organisms were found.

A few cases showed special points of interest. Case 7 showed in her left antrum a staphylococcus aureus, but on a culture made some time previously by Dr. R. A. Cooke, a streptococcus was also found and streptococcus vaccine given.

It is interesting to note that the streptococcus was not found at the later culture, although there had been no clinical improvement at that time.

Case 24, a man of 62 years, had marked exophthalmos and papillitis; very slight involvement of his right antrum and sphenoid were found, showing staphylococcus aureus. These cleared up promptly and were not considered related to his eye condition which was ascribed to an intra-cranial lesion. However, a fairly prompt recovery ensued and he reported himself well a few weeks ago, over six months after his attack.

One case, Mr. W. C. J., not in this series, as he was seen but once in consultation to see if a chronic sinusitis could be the cause of an asthma of 2 years' duration, showed *Aspergillus Niger*. Clinically he did not resemble the cases of Aspergillosis of the sinuses as described by Tilley.⁶

It may be of some interest that eight consecutive, acute cases seen in the little epidemic of colds associated with the recent severely cold weather showed pneumococcus infection.

It is difficult to draw definite conclusions from the above array of facts. One fact, however, stands out prominently and that is the pneumococcus is pre-eminently associated with acute attacks and the streptococcus with chronic sinusitis, staphylococci being well represented in both groups. Also it is to be noted that acute cases are more often associated with a single organism.

In acute cases, obviously, the prognosis is better and the treatment simpler and less prolonged, as has long been known. Very little difference in the length and kind of treatment and results to be expected, in the different groups of acute cases, has been found. Some difference is found in chronic cases, however, and not entirely in accord with the conclusion of Turner and Lewis,⁵ who consider the presence of a streptococcus of bad prognostic significance. In this series the staphylococcus group has the longest average duration treated and a low percentage (62) of cures with a high percentage of operations required (40%).

We regret having no more definite conclusions to offer than to say that as yet the bacteriological findings have not proved any great aid in either prognosis nor in determining the kind of treatment in acute cases, but are of some value in chronic cases. However, they have proved of great interest to those of us who have been doing this work, and seem to promise more on further investigation.

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