

THE BACTERIOLOGY OF SPUTUM IN COMMON NON-TUBERCULOUS INFECTIONS OF THE UPPER AND LOWER RESPIRATORY TRACTS, WITH SPECIAL REFERENCE TO LOBAR AND BRONCHO-PNEUMONIA.*

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In a concise and interesting paper, Kitasato (1) discusses the bacteria in the sputum from pulmonary tuberculosis and gives the simplest and most reliable method of isolating bacteria from sputum containing several organisms. The cultural investigations here recorded were stimulated by the paper of Kitasato and, in 1905, by that of Schottmüller (2); and the article of Norris and Pappenheimer (3) called our attention to the fact that post-mortem bacterial examinations of material from the respiratory tract are not reliable, and showed that careful sputum examinations might be of considerable value in prognosis and also in treatment, now that specific therapy is being developed.

The examinations of infections of the respiratory tract here recorded are for the years 1903 to 1910, and were made upon patients visiting the Dispensary of Cornell University Medical College, upon those admitted to the wards of the Second Division of Bellevue Hospital, and upon a few private patients. The earlier examinations were made by Dr. Hastings and Dr. Mortimer Warren, the later ones by Dr. Armstrong and Dr. Niles. The study of the sputum throughout a series of years has shown a marked yearly variation in the types of infecting organism; so that it is safe to conclude that the observations on one set of cases for a few months have little weight in the determination of the infectivity of an

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organism for the respiratory tract and of the frequency of the association of any one germ with certain clinical symptoms and signs.

THE VALUE OF THE LITERATURE UPON THE BACTERIOLOGY OF THE RESPIRATORY TRACT.

The literature regarding the bacteriology of the healthy respiratory tract below the larynx is voluminous, as the subject has been extensively investigated in man and animals. Nevertheless, in most of the work two serious errors are found which vitiate the strength of the conclusions.

The first error is, that cultures have usually been taken post-mortem, and the findings assumed to represent the bacterial flora ante-mortem. That this is fallacious was shown by the investigations of von Besser (4), and more recently by Norris and Pappenheimer who state: "It follows logically from the results obtained in this experiment that the cultural findings after death are no guide to the bacterial contents of the lungs during life, and that any deductions made from such findings are unreliable and deceptive."

The second error is self-evident and consists in drawing conclusions from examinations of sputum that has been collected without regard to the contamination that must take place unless precautions are observed while the sputum is passing through the pharynx and mouth.

It seems to have been generally assumed that the bronchi and alveoli are normally infected, and such authorities as Baumgarten (5) and Hoffmann (6) state that such is the case. Baumgarten, however, offers no proof, and Hoffmann merely quotes Pansini as having found several species of bacteria in healthy lungs, but gives no details. Dürck (7), who examined healthy lungs of man and animals, is quoted as believing in normal lung infection, but as his work was done post-mortem, his conclusions can not be accepted without reservation.

RESULTS OF EARLIER INVESTIGATIONS IN SPECIAL DISEASES.

It seems hardly worth while to review much of the literature on the bacteriology of respiratory diseases because of the variations in technique and the lack of precautions observed by the investi-

gators. Some of the more recent and important work will, however, be noted.

In acute catarrhal inflammations of the nose, White (8) reports that *B. coryzae segmentosus*¹ was present in fifty out of fifty-six cases examined, and he regards it as the most frequent cause. At the same time (1906), Allen (9) apparently regarded the bacillus of Friedländer as more important. In 1908, however, he reported the bacteriology of forty-two "colds" occurring in London during the previous three years. This time he found *B. influenzae* alone in 2.4 per cent., *B. Friedländeri* in 19.0 per cent., *B. coryzae segmentosus* in 26.2 per cent., and *Micrococcus catarrhalis* in 28.6 per cent. of the cases. He concluded that any of the above mentioned organisms might cause acute nasal catarrh; that subacute catarrh is commonly caused by the bacillus of Friedländer or by *Micrococcus catarrhalis*, but rarely by *B. influenzae*, or by *B. coryzae segmentosus*; and chronic catarrh by Friedländer's bacillus only.

In tracheal catarrhs, Allen (10) concludes that *B. influenzae* or *Micrococcus catarrhalis* are usually found, the bacillus of Friedländer exceptionally. *Micrococcus paratetrigenus* was not found by him, although it has been reported in trachitis by Bezançon and De Jong (11), and by Benham (12).

As inflammation of the bronchial mucous membrane often accompanies specific diseases and often arises independently, it seems well, as Marfan (13) has suggested, to adopt a bacteriological classification. Marfan makes two general groups. Group 1 is due to specific infections (influenza, pertussis, measles, diphtheria, anthrax, plague, tuberculosis, variola, malaria, glanders, and syphilis), and group 2 is due to non-specific infections. These he believes arise chiefly from pneumococci and streptococci.

B. influenzae is constantly found in the bronchitis of epidemic influenza, and Kretz (14), Washbourn (15), and Lord (16) have called attention to its frequency in the respiratory tract in diseases other than epidemic influenza. Davis (17) and Wollstein (18) report an organism, which appears to be identical with the influenza bacillus, as almost constantly present in the sputum of pertussis. Goldie (19) has seen two fatal cases of general bronchitis in which no membrane formed, but from the secretions of which pure cultures of the diphtheria bacillus were obtained.

Many forms of microorganisms have been found in exudates of non-specific bronchitis, and the infection is usually a mixed one, two, or three, or more varieties being present. Undoubtedly some are often secondary invaders, but pathogenic properties have been attributed to many.

Pneumococci and streptococci alone, or associated with each other or with other bacteria, have been most frequently reported. Ritchie (20, 21), who has thoroughly reviewed the literature of the subject, examined forty-nine cases and found these two organisms most commonly. His work, however, like that of many other investigators, is open to the criticism that his cultures, though made from the smaller bronchioles, were taken post-mortem, and may, therefore, be misleading. Among those who found pneumococci predominating are von Besser

¹We have found *B. coryzae segmentosus* once in the sputum of chronic bronchitis in a dog.

(22) and Barthel (23); while Kruse, Pansini and Pasquale (24), Bouchard (25), Claisse (26), Queyrat (27), Cassaët (28), Hoffmann (29), and Forchheimer (30) found streptococci in abundance. Babes and Popesco (31) regard *Staphylococcus aureus* as more important, and Durante (32) reports staphylococci in pure culture in four cases. Patton (33) found streptococci and staphylococci in most cases.

An important recent report is that of Pollak (34), who examined seventy-three cases and found twelve varieties of bacteria, including *B. coli communis*, *B. lactis aerogenes*, and *B. proteus*.

Ghon and Pfeiffer (35) and Sederl (36) have emphasized the importance of *Micrococcus catarrhalis* in acute bronchitis. Others which seem occasionally to be the specific cause are, *B. Friedländeri*, *Micrococcus tetragenus*, and several saprophytes.

The frequency of *B. influenzae* in bronchiectasis has been emphasized by Boggs (37) who reports five cases, in three of which the bacilli were in pure culture, and present with pneumococci in the other two cases. Sections from two fatal cases revealed *B. influenzae* deep in the walls of the bronchi and mostly intracellular.

Lobar (Croupous) Pneumonia.—The *Diplococcus lanceolatus* (pneumococcus) has been so constantly demonstrated in the exudate of acute lobar pneumonia that it is generally regarded as the specific etiologic agent. This view receives corroboration by the demonstration of an accompanying pneumococcemia in a large proportion of cases, Prochaska (38) having found it in all of fifty cases, and Rosenow (39) in 132 out of 145 cases, both believing the blood invasion to be a constant condition. It is probable that other organisms may occasionally induce a pneumonia which can not be clinically or pathologically differentiated from that caused by the pneumococcus.

This property has been long attributed to Friedländer's bacillus, and Schottmüller (2) has described five fatal cases of apparently typical lobar pneumonia, also one non-fatal empyema from which he recovered *Streptococcus mucosus* in pure culture. Secondary invasion by other microorganisms is common, and it seems likely that these may at times influence the course of the disease.

Streptococcus pyogenes is regarded as the most common associate of the pneumococcus, although *Staphylococcus pyogenes aureus*, *B. influenzae*, *B. diphtheriae*, and *Micrococcus catarrhalis* are not infrequent.

Broncho-Pneumonia.—In this form of pneumonia no specific organism has been determined. The infection is usually a mixed one, but in the primary form the pneumococcus alone or associated with others is the bacterium found most frequently. Wollstein (40) took cultures post-mortem from infants and found pneumococci in 81 per cent. of thirty-three cases, and in pure culture in 41 per cent. Two cases showed streptococci alone. *Staphylococcus aureus* was recovered in pure culture from two cases, and in one case it was found in association with *B. coli communis*.

Pfeiffer (35) and Sederl (36) report *Micrococcus catarrhalis* in pure culture from broncho-pneumonia as well as from bronchitis.

In the secondary form, mixed infections are again the rule, all the above mentioned organisms having been found in association with the specific cause of the primary disease.

Sterility of Upper and Lower Respiratory Passages.—In order that the bacteriological findings in exudates from the respiratory tract may be of value in representing the specific cause of an inflammation, it is necessary to establish the validity of two propositions: (1) that most of the normal respiratory tract, particularly its lower part, is sterile, and (2) that it is possible to collect and handle exudates in such a manner that bacterial contamination from the normally infected parts may be obviated.

The Nasal Mucosa.—The evidence regarding the sterility of the healthy nasal mucosa is conflicting. This is principally because of the difficulty in deciding whether or not a nose is really normal, but partly because every precaution may not have been taken in collecting exudates. All agree that large numbers of atmospheric bacteria are constantly found in the vestibula of the nares and on the vibrissæ, which act as filters, and contamination from these sources is likely, unless precautions are observed. The careful work of Fraenkel (41) and Löwenberg (42), who found no bacteria in the interior of healthy noses, is, however, convincing. Others who have found most healthy noses sterile are Hildebrandt (43), Lermoyez and Wurtz (44), and Thomson and Hewlett (45). Lewis and Turner (46) conclude that healthy accessory sinuses are also probably sterile.

The Mouth and Pharynx.—The mouth and pharynx, whether healthy or diseased, are, of course, commonly infected with the atmospheric microorganisms and not infrequently with bacteria, which are commonly pathogenic, notably pneumococci (Hiss, 47).

The Respiratory Tract Below the Larynx.—Many observers, however, have found the air passages of healthy individuals from the glottis down to be usually sterile, or at most to contain very few bacteria. Among these may be mentioned Babes (48), Thomson and Hewlett (49), Müller (50), Barthel (23), Klipstein (51), and Jundell (52).

Jundell carried out a particularly interesting investigation, obtaining mucus from the tracheas of forty-three healthy human beings by means of a special instrument which he devised. That these observations are probably correct is borne out by the following conclusions of Ritchie (20):

- (a) All bacteria contained in inspired air are probably withdrawn in the winding upper air passages.
- (b) The nasal mucous membrane possesses marked bactericidal properties.
- (c) Inspired air remains mostly in the upper portions of the bronchial tract, seldom reaching the alveoli.
- (d) Expired air contains no bacteria.
- (e) Bacteria when introduced into the bronchi or lungs of healthy animals soon die.

We agree with Krehl (53) and Ritchie (20), both of whom conclude that the air passages of healthy individuals below the glottis are usually sterile.

Exudates formed in portions of the respiratory tract that are normally sterile may be collected and treated in a way that will prevent contamination. The anterior nares are readily disinfected and this should be done before collecting exudates from the nose. Contamination in the mouth and pharynx is avoided by the method of Kitasato (1) who collected in a sterile dish sputum from deep coughing, after which he picked a small piece from the center, washed it in sterile water, and then planted it on proper media. If previous to this collection the mouth and pharynx are washed with salt solution or a mild antiseptic, there is little liability of contamination. The more elaborate method of Löwenstein (54) seems unnecessary.²

We assume, therefore, that when the proper precautions are observed, the bacteria found in an exudate from the respiratory tract are the specific cause of the inflammatory process which produced the exudate.

METHODS EMPLOYED AND NOMENCLATURE ADOPTED.

The technique used was that suggested by Kitasato. The mouth and pharynx were rinsed with sterile water or salt solution and then the sputum from a single expectoration was collected in a bottle that had been sterilized by boiling. From the sputum thus obtained the portion to be examined was selected and washed in 0.8 per cent. sterile salt solution.

²Löwenstein collected in a sterile dish early morning sputum after having the patient wash the mouth with a thymol mouth-wash after meals and at night, for the three preceding days. He then washed the pieces of sputum in hot water and followed this with a quick washing in a 3 per cent. solution of hydrogen peroxid.

A *clean sputum*, *i. e.*, one containing only two or three types of bacteria and free from buccal squamous cells, and a *dirty sputum*, *i. e.*, one containing a varied bacterial and fungoid flora and buccal squamous cells, are readily recognized on microscopical examination.

A dirty sputum is not suitable for bacterial examination and should be discarded for a second or third clean specimen from the same patient.

The more carefully the clean specimens are selected, washed, and handled, the more frequently does one obtain pure, unmixed cultures. If collected and handled properly, washing may be dispensed with. Inoculations should be made on tube-slants of plain and glycerine agar and in plain broth, and from the first tube of broth a platinum loop full or two should be transferred to a second tube of broth, from which streaks should be made upon agar plates. Except when *Micrococcus catarrhalis* is present, a mixed flora may, as a rule, be easily separated on the first trial. For differentiation, the usual bacteriological methods are to be followed, namely, the making of cultures upon glucose and other carbohydrate media, upon hemoglobin media, and upon blood serum. Rarely, anaerobic cultures may be necessary.

Whenever the stained smears from the sputum have shown small gram negative bacilli which might be *Bacillus influenzae*, cultures have been made directly upon fresh hemoglobin media.

Nomenclature.—The term micrococcus has been used for the various cocci, including staphylococci, *e. g.*, *Micrococcus aureus*, *Micrococcus albus*, *Micrococcus catarrhalis*. Streptococci³ have been classed, wherever the proper differentiation has been carried out, as *Streptococcus pyogenes (longus et erysipelatos)*, *Streptococcus hemolyans (longus seu brevis)*, *Streptococcus viridans or mitior (longus seu brevis)*.

The *Streptococcus mucosus* and pneumococcus have been considered as more closely related to each other than to the three types of streptococci mentioned.

The bacillus of Friedländer and the other types of closely related

³ Schottmüller (55) classifies the three groups of streptococci as: (1) *Streptococcus longus et erysipelatos*, (2) *Streptococcus mitior seu viridis*, and (3) *Streptococcus mucosus*.

gram negative, encapsulated, aerobic bacilli have been classed under *Bacillus mucosus capsulatus*.

The organisms found were as follows: *Streptococcus pyogenes*, *Streptococcus hemolysans*, and *Streptococcus mitior*, pneumococcus, *Micrococcus catarrhalis*, *Micrococcus tetragenus*, *Micrococcus aureus*, *Micrococcus albus*, *Micrococcus citreus*, *Streptococcus mucosus*, *Bacillus mucosus capsulatus* (which includes *Bacillus Friedländeri*), *Bacillus influenzae*, *Bacillus fluorescens*, *Bacillus pyocyaneus*, *Bacillus coli*, and *Bacillus acidi lactici*.

GROUPS OF NON-TUBERCULOUS DISEASES STUDIED.

Our 183 cases have been divided into nine groups. The first two of these deal with the upper respiratory tract, the larynx, trachea, and larger bronchi, and the other seven with the lower tract, the smaller bronchi, vesicles, and pleuræ.

Group 1 consists of twelve cases; *i. e.*, acute laryngitis (2), acute trachitis (9), and chronic trachitis (1).

Group 2 contains twenty-seven cases of grippe, nineteen of these with or without coryza (including influenza), and eight with no diagnosis other than grippe, probably acute bronchitis (including influenza).

Group 3 embraces nine cases of acute bronchitis.

Group 4 consists of forty-eight cases of chronic bronchitis.

Group 5 embraces sixty-six cases of lobar pneumonia. In only twenty-three of these were pneumococci found in culture.

Group 6 includes twelve cases of bronchial pneumonia; three were typical, and nine atypical, the so-called grippe or influenza pneumonia.

Group 7 contains two cases of bronchiectasis.

Group 8 consists of two cases of asthma.

Group 9 includes five cases of pleuritis, or pleurisy, with no other diagnosis.

SUMMARY OF CULTURES FROM GLOTTIS DOWN, IN ORDER OF FREQUENCY.

Organisms	No. of positive sputa.	Percentage of occurrence
<i>M. catarrhalis</i>	71	21.0
<i>M. aureus</i>	52	15.0
Streptococci	50	14.0
Pneumococcus	45	13.0

= 63.0

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<i>M. tetragenus</i>	35	10.0	
<i>M. albus</i>	21	6.0	
<i>B. Friedländeri</i>	13	4.0	
<i>B. influenzae</i>	6	1.5	
			= 21.5
<i>Streptococcus mucosus</i>	5	1.5	
<i>M. citreus</i>	4	1.25	
<i>B. fluorescens</i>	4	1.25	
			= 4.0
<i>B. coli</i>	3	1.0	
<i>B. pyocyaneus</i>	3	1.0	
<i>B. proteus</i>	3	1.0	
<i>Oidium albicans</i>	2	- 1.0	
<i>Hay bacillus</i>	2	- 1.0	
<i>B. acidi lactici</i>	1	+ .5	
			= 5.5
Unidentified organisms	11	3.0	
Total No. of isolations =	331		= 97.0
Sputa culturally negative	10	3	
Total No. of cultures =	341		100

SUMMARY OF CULTURES BY YEAR.

Year.	Number.	Most common.	No. of times isolated.	Per cent.
1. 1903-04	34	Pneumococcus	8	23.5
		<i>M. catarrhalis</i>	7	20.5
		<i>M. aureus</i>	5	14.5
		<i>M. tetragenus</i>	3	9.0
		<i>M. albus,</i>	3	9.0
		Other organisms and negative cultures	8	23.5
		2. 1904-05	63	<i>M. catarrhalis,</i>
Streptococci	9			14.0
<i>M. tetragenus</i>	8			13.0
Pneumococcus	6			9.5
<i>M. aureus</i>	6			9.5
Other organisms and negative cultures	16			25.0
3. 1905-06	31			<i>M. catarrhalis</i>
		<i>M. tetragenus</i>	4	13.0
		<i>M. aureus</i>	4	13.0
		Pneumococcus	3	10.0
		Other organisms and negative cultures	15	48.0
4. 1906-07	23	<i>M. tetragenus</i>	5	22.0
		Streptococci	4	17.5
		Pneumococcus	3	13.0
		<i>Streptococcus mucosus</i>	3	13.0
		Other organisms and negative cultures	8	34.5

5. 1907-08	84	<i>M. catarrhalis</i>	17	20.5
		Streptococci	16	19.5
		<i>M. tetragenus</i>	12	14.0
		Pneumococcus	12	14.0
		Other organisms and negative cultures	27	32.0
6. 1908-09	55	Streptococci	12	22.0
		Pneumococcus	10	19.0
		<i>M. catarrhalis</i>	9	17.0
		<i>M. aureus</i>	8	15.0
		Other organisms and negative cultures	16	27.0
7. 1909-10	51	<i>M. aureus</i>	18	35.5
		<i>M. catarrhalis</i>	15	29.5
		Streptococci	6	11.5
		Pneumococcus	3	6.0
		Other organisms and negative cultures	9	17.5
Total number of cultures			341	

THE ORGANISMS PRESENT IN THE CLINICAL GROUPS.

Group 1 (Laryngitis and Trachitis).—The organisms most frequently isolated were: *Micrococcus catarrhalis* (7 times) and *Micrococcus aureus* (6 times). Pure cultures of *Micrococcus aureus* were obtained in 3 cases, and *Micrococcus catarrhalis* in 1.

Group 2 (Grippe and Influenza, probably with Acute Bronchitis).—In this group *Micrococcus catarrhalis* was the organism most frequently isolated (15 times), streptococci⁴ were found in 7 cases, and the pneumococcus in 7. *Bacillus influenzae* was present in 7, and *Micrococcus tetragenus* in 6 cases. In 8 instances the sputa gave pure cultures: *Micrococcus catarrhalis* in 4, *Micrococcus albus* in 2, *Micrococcus tetragenus* in 1, and streptococcus in 1.

Group 3 (Acute Bronchitis).—*Micrococcus catarrhalis* was the organism most commonly found, being isolated 6 times. Two of the cases gave pure cultures, one of *Micrococcus catarrhalis* and one of pneumococcus.

Group 4 (Chronic Bronchitis).—The organisms isolated from this group and their frequency were as follows: *Micrococcus aureus* (17), streptococci (15), *Micrococcus catarrhalis* (13), *Micrococcus*

⁴The types of streptococci have not been separated for this report. From a study of the types isolated from specimens in this laboratory they have been classed as (a) *Streptococcus pyogenes* (*longus et erysipelatos*), (b) *Streptococcus hemolysans* (*longus seu brevis*), and (c) *Streptococcus viridans seu mitior* (*longus seu brevis*). Our classification is a modification of that of Schottmüller.

tetragenus (10), pneumococcus (8), *Streptococcus mucosus* (4), *Bacillus influenzae* (1). Pure cultures were obtained in 18 cases, as follows: *Micrococcus aureus* (7), *Micrococcus albus* (2), pneumococcus (2), *Micrococcus catarrhalis* (1), streptococci (1), *Streptococcus mucosus* (1), *Micrococcus tetragenus* (1), *Bacillus coli* (1), *Bacillus pyocyaneus* (1), Friedländer's bacillus (1).

Group 5 (Lobar Pneumonia).—There were twenty-three cases with pneumococci and forty-three cases with no pneumococci in the sputum. These results do not represent the proportion of cases in which the pneumococcus occurs in lobar pneumonia, for many of the cultures were taken because the clinical manifestations of the disease were atypical.

Of the twenty-three sputa giving pneumococci, nine revealed them in pure culture. The organisms were as follows: *Micrococcus catarrhalis* in 7 cases, streptococci in 3, *Micrococcus aureus* in 3, *Micrococcus tetragenus* in 5, *Micrococcus albus* in 5, Friedländer's bacillus in 1, *Bacillus proteus* in 1, *Micrococcus citreus* in 1, and unidentified organisms in 6.

From the forty-three sputa without pneumococci in cultures, the following organisms were most frequently recovered: streptococci in 14, *Micrococcus catarrhalis* in 16, *Micrococcus aureus* in 11, *Micrococcus tetragenus* in 8, Friedländer's bacillus in 4, and *Bacillus coli* in 2 cases. The pure cultures from these cases were 18 in number, as follows: *Micrococcus aureus* in 6, streptococci in 5, *Micrococcus catarrhalis* in 4, *Bacillus coli* in 1, *Bacillus proteus* in 1, and *Micrococcus citreus* in 1.

Fresh smears were made from every exudate, and in only four of the above were capsulated cocci in pairs observed. In four of the negative cases the pneumococcus was found neither in cultures nor smears. In three others the cultures were reported negative for pneumococci and smears were positive for pneumococci. We consider that a few scattered pneumococci might be found in smears from buccal cavity contamination, while the cultures might be negative. The opposite of this, *i. e.*, that smears might be negative and cultures positive, is untenable, and our results bear this out. The hay bacillus in one case was a contamination.

From lobar pneumonia the most common isolations were: the

pneumococcus in 23 instances, *Micrococcus catarrhalis* in 23, streptococci in 17, *Micrococcus aureus* in 14, *Micrococcus tetragenus* in 13, *Micrococcus albus* in 7, *Bacillus Friedländeri* in 5, *Bacillus proteus* in 2, *Bacillus coli* in 2, *Bacillus fluorescens* in 1, *Micrococcus citreus* in 3, and unidentified organisms in 6. The total number of isolations from lobar pneumonia was 110.

Group 6.—In broncho-pneumonia the organisms most frequently isolated were: *Micrococcus catarrhalis* in 5 cases, streptococci in 4, *Micrococcus aureus* in 14, pneumococcus in 2, and *Bacillus Friedländeri* in 2. Pure cultures were obtained from seven cases, as follows: *Micrococcus aureus* from 3, *Bacillus Friedländeri* from 2, *Bacillus pyocyaneus* from 1, and pneumococcus from 1.

Group 7.—One exudate from bronchiectasis revealed a pure culture of the streptococcus, and from the other were isolated *Micrococcus albus* and *Bacillus proteus*.

Group 8.—From the bronchial asthma group, *Micrococcus catarrhalis* and the *Micrococcus tetragenus* were each isolated once in pure culture.

Group 9.—The five cases of pleurisy in this group could not be proven tuberculous. The production of sputum is evidence of some condition other than pleurisy, but no other diagnosis appeared in the records. The pneumococcus was isolated in 3 cases; the micrococcus in 2; *Bacillus Friedländeri* in 1; and *Bacillus fluorescens* in 1. One case gave a pure culture of pneumococcus.

The yearly variation is noteworthy, and also the fact that it can not be accounted for by variations in the number of examinations made in the different years. The organisms which were first in frequency, and the winter seasons from 1903 to 1910 inclusive during which they were first, are as follows: *Micrococcus catarrhalis* (1904-05), *Micrococcus catarrhalis* (1905-06), *Micrococcus catarrhalis* (1907-08), pneumococcus (1903-04), streptococci (1908-09), *Micrococcus aureus* (1909-10), *Micrococcus tetragenus* (1906-07); and those second in frequency were: pneumococcus (1908-09), streptococci (1904-05), streptococci (1906-07), streptococci (1907-08), *Micrococcus catarrhalis* (1903-04), *Micrococcus catarrhalis* (1909-10), *Micrococcus tetragenus* (1905-06).

SUMMARY.

1. In our examinations, only 38 per cent. of the infections of the respiratory tract below the glottis were pure, and this percentage was reached only by carefully following Kitasato's method of handling sputa.

2. Lobar pneumonia may produce sputum free from pneumococci, and may undoubtedly be caused by organisms other than the pneumococcus.

3. There is found a marked yearly variation in the organisms which excite inflammation of the respiratory tract.

4. *Micrococcus catarrhalis* is usually considered a common secondary invader; but it may, and probably frequently does, assume pathogenic properties.

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