STREPTOCOCCAL INFECTION BY THE NASAL
AND BUCCAL PATHS.*

BY

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It is interesting to trace the recognition of the nasal and buccal areas as points of incidence of infection. From 1885 to 1890, in the early days of bacteriology, many varieties of unclassified and unnamed bacteria were demonstrated in sections of decayed teeth and by needle culture from teeth cavities. Later came Hunter, with his researches on pernicious anaemia, which he attributed to absorption from drain infection, septic teeth, or septic mucous membranes connected with teeth, producing a subacute or chronic systemic bacterial infection. Later it was accepted that frequently after an attack of acute tonsillitis there followed in about fourteen days a more or less subacute rheumatism. This pointed to the tonsillar pharyngeal mucous membrane as an area of infective incidence. Then came the recognition of pyorrhoea with its strepto-bacillus and its importance as a possible cause of many diseases, prominently rheumatic diseases. We know of cases of acute streptococcal poisoning from Ludovic angina types, also from septic tonsillar abscesses, sometimes associated with infectious diseases, frequently not; also of cases of septicaemia following tonsillar or turbinal manipulations. We have accessory sinus suppurations due to streptococcal infection, and cases of rheumatic fever sometimes following excision or enucleation of the tonsils too soon after rheumatic tonsillitis. Again, in association with influenza epidemics, at odd times and places we meet with cases of streptococcal pneumonia, primary and secondary, with a high mortality; and, most important of all, a definite recognition and classification has been given within the last few years to the infective endocardial conditions.

The question I wish first to discuss is the path of infection of these various systemic conditions and the prominent part played by the nose, nasopharynx and throat, and the lymphatics and veins associated with these organs.

Paths of Infective Distribution from Nasal, Nasopharyngeal and Buccal Membranes.

Lorrain Smith has strongly emphasized the question of the incidence and distribution of any and all infections; what determines the selective distribution of organisms to any particular organ or organs? We do not know why streptococci from the mouth or nose should select the fibrous thickened cardiac valve-cusps for attack, as in subacute infective endocarditis, or why tuberculous infection in some cases should select the suprarenal glands, ignoring the nearer and larger organs. Rosenow and others in America have recently demonstrated the possibility of duodenal and gastric ulcers, appendicitis and colitis, being due to streptococcal infection from the mouth and teeth. Many of these diseases are possibly merely local craters in a general blood infection.

Venous and Lymphatic Drainage.

The mouth venous drainage is mainly by the pterygoid plexus and facial veins to the internal jugular vein and so into the circulation, and from the tongue directly by lingual veins into the internal jugular vein. There are also connexions with the pharyngeal venous plexus. The teeth venous drainage passes from the inferior and superior alveolar veins into the pterygoid plexus and facial veins and thence to the internal jugular vein. The mouth lymphatics drain to the submaxillary, submental and parotid lymph glands, whose efferents pass to cervical lymph glands. The tongue lymph glands drain from the sides and middle of the dorsum to glands at the carotid bifurcation. The teeth lymph drains to the submaxillary, submental and parotid lymph glands.

The nasal venous drainage is mainly to the pterygoid plexus from the sphenopalatines in the sphenopalatine foramen, also importantly connected with ethmoidal tributaries of the superior ophthalmic veins and tributaries of the angular vein at the bridge of the nose. Infection might pass this way into the orbit or to venous sinuses as the ophthalmic veins enter the cavernous sinus and the angular veins are connected with the anterior end of the superior sagittal sinus. The nasal external lymph vessels pass to parotid and submaxillary lymph glands, and some few to the superficial

cervical lymph glands. The muco-periosteum anteriorly drains externally to the submaxillary glands and posteriorly to the superior deep cervical glands and the lateral retropharyngeal glands. The nasopharyngeal venous drainage is mainly sphenopalatine, etc., into the pharyngeal plexus and thence to the internal jugular vein. The nasal lymphatic drainage is to superior deep cervical lymph glands, and some to the retropharyngeal lymph glands—hence arise retropharyngeal abscesses.

The palatine tonsil lymph vessels pierce the pharyngeal wall laterally and end in glands on the internal jugular vein below the posterior belly of the digastric at the level of the angle of the jaw. The venous connexion of these regions with the meninges is brought about by the drainage into the venous pterygoid plexus, which receives (1) emissary veins through the foramen ovale from the cavernous sinus, and (2) connexions from the inferior ophthalmic vein through the inferior orbital fissure. A circle is thus formed by the pterygoid plexus, nasal veins and other connexions, with ophthalmic veins and the superior longitudinal sinus, the ophthalmic veins entering the cavernous sinus and emissary veins passing to the pterygoid plexus.

Bacteriology of the Nasal, Nasopharyngeal and Buccal Mucous Membranes.

Broadly speaking, the nasal healthy secretion is non-bacterial. The sinuses if healthy are sterile, the vestibule is usually bacterial and sometimes pathogenic, containing varieties of staphylococci and micrococci and streptococci. In 26 cases of healthy mucous membrane, Lewis and Turner found streptococci in 6, staphylococci in 13, and pneumococci in 4. In an unhealthy nose and nasopharynx the three prominent bacteria are streptococci, staphylococci and pneumococci in varying strains, together with at times the influenza bacillus and certain putrefactions and coryzal bacilli, etc. All nasal inflammations are due to pathogenic organisms, either virulent, or capable, if avirulent, of being stimulated to virulence by chills, traumatism or debility; hence the onset of acute sinus abscesses after coryzal colds and sore nose conditions in extreme asthenia during pulmonary tuberculosis, typhoid fever, etc.

The nasopharyngeal and mouth varieties of organisms are much the same as the nasal, and are derived from food, water, and air. Teeth show organisms on the surface of dentine, and also in the deeper tissues. Mouth acids are always a result of bacterial action; they decalcify teeth, and so start caries; thus in deep dental caries we find streptococcal varieties along with the *Bacillus necrodentalis*, etc. There are many varieties of bacteria in the mouth—fermentative, pathogenic, etc. Accessory sinuses are sterile if healthy. If unhealthy, they usually show streptococci, staphylococci, and pneumococci, with catarrhal bacteria, and sometimes the *Bacillus coli communis*; in other words, the same varieties of bacteria as are found in the buccal and nasal cavities. In a hundred cases investigated (Lewis and Turner) 75 per cent. showed streptococci, 74 per cent. showed pneumococci, and 70 per cent. staphylococci, with occasional *Bacillus diphtheriae* and *Bacillus influenzae*, etc. These details are from the research works of Lewis and Turner, Reynolds, Fraser, Ritchie, etc.

Antral suppurations are 58 per cent. nasal in origin, 30 per cent. of these beginning by influenza attacks; 14 per cent. only are coryzal in origin, 37 per cent. are due to infection from teeth, and 2 per cent. are traumatic (Lewis and Turner). Streptococci are more numerous in chronic than in acute sinus suppurations, in the proportion of 80 per cent. to 60 per cent. Thus from nasal, nasopharyngeal and buccal cavities the above pyogenic organisms, together with Pfeiffer's bacillus, pneumococci, meningococci, and tubercle bacilli, are capable of passing to the brain, probably by venous channels, and producing such diseases as suppurative, influenzal, pneumococcal, and epidemic cerebro-spinal meningitis, also probably acute poliomyelitis and tuberculous meningitis, tuberculous and septic cervical glands; and, by way of the Eustachian tube, middle-ear disease and mastoid infection; while in the general system by absorption through the lymphatic channels of mouth and nose and nasopharynx, pneumonia, pernicious and septic anaemias, infective endocardial conditions, rheumatoid arthritis, etc., may be established. The main paths of infection are the lymphatic channels, but probably venous to the meninges. Broadly speaking, the same infective chief organisms—namely, the streptococci, staphylococci and pneumococci—are found in the nasal, pharyngeal and mouth mucous membranes, and by way of the Eustachian tube the

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same organisms may infect the middle ear and the mastoid cells. They may infect the brain cavity, as previously described, but probably only by venous routes, as only efferent lymphatics from the brain have been demonstrated.

It is not necessary to describe cases such as suppurative meningitis, middle-ear disease, mastoid abscess, Ludwigian angina types, acute septic tonsillitis, or acute accessory sinus suppurations. These are all direct and acute and call for direct surgical treatment chiefly. Let me now rather briefly describe the course of streptococcal pneumonia, subacute infective endocarditis, pernicious (Addisonian) anaemia, and rheumatoid arthritis, which are more indirect, subacute and purely medical conditions giving very unsatisfactory results by all known treatment up to date.

Streptococcal Pneumonia.

In what may be called primary acute streptococcal pneumonia there is usually severe deep central pulmonary pain referred to the deep subclavicular region. Distress is severe, with a general early toxic appearance, a rapid pulse of 120 or more which remains high though the temperature may be remittent, while delirium is frequently early. Respiration from the first day runs to 30 and upwards, sputum is not typically rusty and viscid, and dullness is only comparative, with marked diminished breath sounds and much confused moist crepitations. If these cases survive the first five days they often fail to complete hepatization with its dry tubular breathing, but they continue more bronchopneumonic with increasing myocardial weakness, with frequently progressive infection to other parts of the lung, such as centre to apex to base, which in a week or ten days later may pass to the other lung.

The usual termination in this migratory form of pneumonia is death. This was the type of pneumonia I first saw in 1893, in an epidemic of influenza which broke out in the *Caledonia* training ship at Queensferry. The first symptoms in most cases were followed in twelve hours by delirium, and often death inside of two days. The same type of pneumonia characterized the devastating influenza epidemic of 1918-19. In the *post-mortem* examinations of the 1893 cases we usually found numerous areas of what would be best described as bronchopneumonia, but sometimes both lobar and lobular, with liquid purulent centres from which we cultivated streptococci and other unclassified organisms. Secondary streptococcal pneumonia is well known in regard to septic surgical and puerperal cases. The Johns Hopkins reports on epidemic pneumonia in the American army in 1918 state that it was of the above type, all cases showing streptococci and some also the influenza bacillus (30 per cent. only).

Let me now describe a few cases showing the unexplainable selective distribution of the streptococcus in the general system.

Subacute Infective Endocarditis.

This is found developing in endocardial lesions of long standing, especially in incompetency of the aortic or pulmonary valves. The disease, first described by Osler in 1908 and Horder in 1909, was thoroughly detailed by Cotton in the *BRITISH MEDICAL JOURNAL* of December 4th, 1920, and again described and discussed, chiefly by Horder and Libman, at the British Medical Association meeting of 1920. It is a remarkable fact that rheumatism and syphilis attack healthy heart valves, whereas subacute infective endocarditis only attacks primarily diseased valves of rheumatic causation; hence it is suggested that we should endeavour to prevent this dread ailment by specially immunizing rheumatic valvular diseased patients against the *Streptococcus anhaemolyticus*, the main cause of the disease. This is advised by Horder and Libman. It affects patients from 15 to 50 years of age. It grafts on the fibrous lesions in the cusps, sometimes on the lesions on septum or edges of a patent ductus, and thus sometimes you have little or no murmur to guide you. It is well marked but subacute and insidious in its early advance, so much so that many cases carry on their ordinary work as before for several months of an illness ranging from about six to eighteen months.

A man aged 49 at the age of 7 had an obscure rheumatic attack of seven weeks' duration; I sent him to Sir James Mackenzie in 1908 suffering from pulmonary valve incompetency probably due to the illness at 7 years of age. He stated that in April, 1920, he began to have what he thought were recurrent malarial rigors, having had malaria several times in South America, between 1909 and 1915. He consulted no one, but went out to the Argentine on business, as he did yearly from July to November. He noticed that he was losing weight in September, and also noted a rise of temperature

at night. In the early part of October he had a very bad epistaxis so severe that he went to the British Hospital, where his nose was plugged. He had blood examinations for malaria, syphilis, tubercle, etc.; no organisms were found, but no blood cultures were made. He was advised to return to London at once owing to the great heat. He arrived in London on December 8th, and came under the care of Dr. Robert Hutchison. His nose was cauterized at once. Blood cultures were then taken, and all of them showed *Streptococcus anhaemolyticus*. There was marked loss of flesh; the heart showed a loud basal murmur, there was oedema of the legs, intermittent septic temperature, pulse rate 106 to 120, unequal, irregular and soft; a large palpable spleen and petechial crops on the upper arms, forearms, legs, and neck, venous engorgement of the neck, sweating and variable pains in the legs, back, and joints. On arriving in Cumberland on December 30th I found, additional to these, slight clubbed fingers, with painful areas on the palmar aspect of the finger ends and over the great trochanters. The heart was enlarged fully two inches beyond the nipple line, with a diffuse heaving impulse. The spleen margin was three inches below the ribs. There was marked septic twitching of the muscles of fingers and toes. The urine showed blood cells with hyaline and granular casts. The urine was also deficient, with albumin, but only a slight trace; his complexion was chlorotic, with pink malar patches. He showed rapid progressive emaciation, very fickle digestion, constipation, and a moist middle furred tongue.

I got Professor Gulland to see him, and we again examined his blood, which now revealed no organisms. By blood count the red corpuscles were 2,800,000, and the haemoglobin 55 per cent.; the colour index was 0.9; white corpuscles gave 3,300; there was a definite glycogen reaction, septic proof. The differential count of the white corpuscles gave: Small lymphocytes 11.3, large lymphocytes 1.7, polymorphs 86, and eosinophiles 0.3 per cent. There was only a slight poikilocytosis, but marked rouleaux formation. The case steadily got worse with frequently recurring emboli to the kidneys, brain, lung, and spleen. He died from gradual exhaustion by toxæmia on February 3rd, 1921. I would reckon his full term of illness at about ten months.

The curious points to note were that his cardiac murmur never appreciably altered, and that petechiae came in frequently increasing crops; the embolic disturbance of the kidneys gradually lessened the urine, but did not markedly increase the albumin. I had no *post-mortem* examination, but these cases usually show recent vegetations, soft and friable, grafted on the cusp regions and the septal wall—hence the emboli—a large spleen with infarcts, swollen and soft, slight nephritis of the parenchymatous type, with destroyed glomeruli and many infarcts; the lungs are usually oedematous at bases, the streptococci usually numerous in the soft cusp vegetations, but sometimes are shut in. The main early symptoms to look for are: Gross valvular disease of the cardiac valves, pallor, enlarged spleen, and clubbing of the finger-tips; some pyrexia—aortic regurgitant cases show it most, mitral disease alone rarely shows it. There is a marked increase in the incidence of this disease.

Pernicious Anaemia.

In pernicious (Addisonian) anaemia we have a systemic infection characterized by intense haemolysis with alteration in size and shape of the red corpuscles; chlorotic appearance, no emaciation, no temperature variations unless in some post-*puerperal* and post-traumatic cases. Under arsenical treatment we get frequent recoveries, with the reds increasing from as low as 30 per cent., and haemoglobin from about 30 per cent., to nearly normal, only to be followed by relapses again and again, until sickness and diarrhoea, indicating intense infection of the gastric and intestinal mucosa, develop. This, unless checked by serum or vaccine treatment, rapidly produces death, accelerated by myocardial weakness.

Rheumatoid Arthritis.

In rheumatoid arthritis, or more correctly, peri-arthritis, we again have a systemic infection with joint swellings, progressive, variable and painful. It is usually primarily associated with agencies which lower the general health, hence we must remember to raise this in conjunction with other treatment. Of course we again wonder why the causative bacteria in the general infection select the joint structures as their principal area of activity.

TREATMENT.

(a) General to all. Inasmuch as all these nasal, antral, buccal, and nasopharyngeal infections are due to unhealthy mucous membranes, etc., the first treatment, if at all possible, should be to eradicate all possible unhealthy nasal conditions—sinus polypi or suppurations, adenoids, tonsils, and teeth, not forgetting septic or tartared plates, but I must advocate conservatism as to teeth.

(b) In streptococcal pneumonia. In addition to usual hygiene, nourishment, stimulants, medicines, etc., anti-

streptococcic polyvalent serum may help; it will certainly do no harm. Stock vaccines are dangerous, and are not held to be sound practice. If an autogenous vaccine can be prepared in very small initial doses, good results may occasionally be got, but it should be carefully used.

(c) In infective subacute endocarditis. In addition to hygiene, nourishment and stimulants, the only treatment with any chance of success seems to be a vaccine (autogenous) or horse serum; antistreptococcic and similar vaccines are useless. Even vaccines show no record of value. Horder and Libman's suggestion to adopt preventive measures in all cases of cardiac lesions of inefficiency by immunizing patients with vaccines of *Streptococcus anhaemolyticus* (or *viridans*) is sound, and the only hope so far.

(d) In rheumatoid arthritis. Much can be done by steady perseverance in raising the general health by diet, clothing, exercise, and climate. Guaiacol carbonate, salol, and quinine salicylate help to eliminate the rheumatoid poison. The urine odour is some guide to this elimination. Iron as iodide with malt and arsenic is useful in improving tissue tone. Radium, in waters, promises good results. Electric and thermal treatments have their partial successes, but vaccines are giving more hopeful results on autogenous lines, being prepared from cultures from the teeth, throat, faeces, or urine. Phylacogens prepared from rheumatic streptococci, etc., I have had experience of, but cannot speak of any success. The disease may be due to several infections; if you can find the definite organism, or organisms, autogenous vaccines would possibly do well.

In conclusion, it is evident that we know very little as to the incidence, varying virulence, and selective distribution of pathogenic and pyogenic bacteria. There is a great field of research open to the collaboration of anatomist, bacteriologist, pathologist and dental surgeon. We in this Border Counties area miss much of the clinical picture in difficult and obscure cases through want of a local pathological department. As to treatment, we must have confidence in future research, so that our treatment may become less empirical and general, and more scientific and accurate.

THE END-RESULTS OF SANATORIUM TREATMENT OF TUBERCULOSIS:

A RECORD OF SEVENTEEN YEARS' SANATORIUM WORK.

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The results of sanatorium treatment of patients from the industrial classes have recently been the subject of a good deal of criticism. We propose to publish figures setting forth up to date what has happened to patients admitted to Kelling Sanatorium between 1903 and 1919, and to let these figures speak for themselves. One of us (W. J. F.) has devoted a great deal of time to keeping in touch by continual visits and letters with all our old patients. The only claim we make for this publication is that our patients have perhaps been followed up more closely than is practicable in larger cities, or with more shifting rural populations.

Between 1903 and 1919 sanatorium treatment was given to 3,220 patients. Of this number 460 have been lost sight of, so there remain for consideration 2,760 patients, whose fate at the end of 1921 is here given:

Treated at sanatorium from 1903 to 1919 ...	2760
Living in 1921 ...	1125 = 40.7%
Dead ...	1635 = 59.2%

Our patients on admission were classed as follows:

Class I ...	1118 = 42.3 per cent.
Class II ...	801 = 29.0 "
Class III ...	841 = 30.4 "

Before comparing these figures with those published by Dr. Noel Bardswell in the November issue of *Tubercle*, and in his memorandum to the London Insurance Committee, we must explain that we have been obliged to adhere to our original classification,

Dr. Bardswell's * Class I included only 25 per cent. or less of the total number of applicants, but his definition of this group is limitation of physical signs to the apex of one or both lungs, and the apex is considered as that part accessible to examination in the supraclavicular and suprascapular fossae. We quite agree with this restriction for Class I cases, but in the present communication that class includes cases whose physical signs denoted the involvement of an area of lung not exceeding that of one lobe, provided that severe constitutional symptoms and complications were absent.

In regard to ultimate results according to classification on admission to the sanatorium, Dr. Bardswell also emphasizes the great importance of the presence or absence of tubercle bacilli in the sputum. We are unable to make this distinction with our cases. In an immense majority the tubercle bacillus was demonstrated in the sputum; in the remainder we only concerned ourselves to obtain other unequivocal evidence that the patient was affected with tuberculosis of the lung.

The next table shows the different results according to the patient's classification on admission:

			Living.		Dead.	
Class I	...	1118		724 = 64.7 %		394 = 35.2 %
Class II	...	801		274 = 34.2 %		527 = 65.7 %
Class III	...	841		127 = 15.0 %		714 = 84.8 %

If, therefore, we confine ourselves to the consideration of the more favourable class of applicants for treatment, instead of a mortality of 59.2 per cent. we get a mortality of 35.2 per cent. for the nineteen years. It is interesting to contrast these figures with those of Dr. Bardswell. His first class were, as we have seen, more strictly selected and their mortality was about 30 per cent., but his period embraced only four years. The excessive mortality which occurs during the first few years after discharge from the sanatorium is a point to which we shall refer shortly. The real crux of the matter, however, is the durability of the restorations of health obtained by sanatorium treatment. The next table gives the percentage of our patients now known to be living and to have died, arranged in their classes and according to the year of their discharge from sanatorium. We would repeat that our Class I was too broad and included a number of cases that we would now place in Class II.

Percentage Discharged.

Years.	Class I.		Class II.		Class III.	
	Living.	Dead.	Living.	Dead.	Living.	Dead.
1903-1905 ...	44.0	56.0	14.0	86.0	4.3	95.7
1906-1908 ...	54.5	45.5	20.2	79.8	8.8	91.2
1909-1911 ...	56.8	43.2	18.5	81.5	8.4	91.6
1912-1914 ...	58.0	42.0	36.5	63.5	14.4	85.6
1915-1917 ...	61.7	38.3	43.9	56.1	21.3	78.7

Of our Class I patients who left the sanatorium between 1903 and 1908, so long ago as thirteen to nineteen years, about one-half are, therefore, still alive. The crucial period is the first four or five years after treatment, and of those who survive this time a large proportion maintain their ascendancy over the malady for an indefinite number of years. This point is forcibly brought out by the next table, which gives the percentages of deaths occurring in five-year periods subsequent to discharge from the sanatorium.

Of those that died, death occurred as follows:

Within 1 year ...	in 6.0 per cent.
Within 1 to 5 years ...	in 57.6 "
Within 5 to 10 " ...	in 23.0 "
Within 10 to 15 " ...	in 9.2 "
Within 15 to 20 " ...	in 2.9 "

Of all the patients who died after receiving sanatorium treatment, the average length of time between the appearance of the first definite symptom and death was just over five years. Publications which dwell on the number of deaths which occur within a few years of leaving the sanatorium give, in our opinion, an unnecessarily gloomy aspect of the story.

* This classification is that adopted by the London County Council Public Health Department after consultation with the Tuberculosis Department of the Ministry of Health.