Sometimes a blood transfusion may cure the patient without operation, even though tenderness is present. The following case is an example:

A boy, aged 14, had a so-called "Brighton" throat in 1931, with severe epistaxis, and headache over the right eye; he was very pale and the temperature rose to 102°. Pain in the right ear followed. The membrane was red and bulging, and already there was tenderness over the mastoid. On incision of the membrane a serosanguineous discharge escaped. In view of the boy's poor general condition and considerable loss of blood, a blood transfusion was given. Recovery was dramatic; in two days all tenderness disappeared.

Blood transfusions and pentnucleotide injections mark a great advance in the treatment of severely ill cases of infection; I have seen recovery accelerated and life saved by both procedures. Actually I am wondering whether pentnucleotide alone would not raise some patients' resistance so much as to avoid the transfusion.

Case 1.—A young man suffered from a mucopurulent discharge from the right ear for three months. A simple mastoid operation was performed, and pus was found throughout. The wound healed, but the ear continued to discharge. A further operation was performed, and small cells were found in the root of the zygoma; A few days later the

temperature rose, and the patient became ill. Cultures from the blood produced a profuse growth of streptococci. A blood transfusion was given. Two days later there were streptococci in the blood, and after another two days streptococci were still recovered from the blood, but they were much fewer. The third culture of the blood produced no streptococci, but the white cells were only 4,000 per c.mm. There followed a third blood transfusion and a dose of pentnucleotide; and thereafter there was slow but steady recovery.

Case 2.—A boy, aged 11, had an acute mastoiditis for which operation was performed. Although the wound appeared satisfactory, and the ear discharge ceased, the boy complained of severe pain over the homolateral eye and temple. This headache continued at intervals for four weeks; it was so severe that he lay with his hand pressed on the forehead and temple and begged his mother to keep her hand pressed there too. Dr. Riddoch saw the boy and transferred him to London, where I was asked to see him. After discussion it was suggested that a condition of petrositis was the cause of the severe pain. The previous wound was opened, and pus was found in a cell at the apex of the petrous, from which a considerable amount of creamy pus flowed. The boy was still ill, and the blood count showed only white cells. Blood transfusion was performed by Dr. Knott, and a small dose of pentnucleotide was given. The improvement in twenty-four hours was dramatic, and a perfectly smooth recovery followed.

ACUTE STREPTOCOCCAL INFECTIONS OF THE THROAT*

BY

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Acute streptococcal infection of the pharynx and larynx was known forty years ago as a number of different conditions. It was called acute septic inflammation of the pharynx and larynx; phlegmon of the pharynx and larynx; acute inflammatory oedema; erysipelas of these structures; and finally, phlegmonous cellulitis of the neck—that is, Ludwig's angina.¹ In 1895 Felix Semon read a paper at the Royal Medical and Chirurgical Society in which he argued that all these various forms of acute septic inflammation of the throat should be considered as varying degrees of virulence of one and the same pathological process. There is a great variation in the clinical signs and symptoms depending upon the severity and type of the infection, the resistance of the patient, and the situation of the lesion.

For clinical purposes two chief degrees of inflammation are recognized:

1. Tonsillitis, with considerable variation in the severity and in the extension of the inflammation and oedema to surrounding tissues.
2. A gangrenous inflammation, with a sloughing membranous exudate and toxæmic and septicaemic symptoms which often begins with acute tonsillitis, and is a later stage of the more severe types of the first group.

Symptomatology

There are many cases between these two somewhat extreme types. Tonsillitis is more common in children and young subjects. The septicaemic and virulent infection of the pharynx occurs in elderly patients, often as an intercurrent disease in such conditions as nephritis or chronic alcoholism. In the fulminating virulent cases the oedema spreads from the tonsils to the fauces and uvula, then down the lateral wall of the pharynx to the epiglottis and arytenoids. When the epiglottis or arytenoids are involved the pain and difficulty in swallowing

are markedly increased, so much so that there is almost complete inability to swallow even saliva. In a very large proportion of cases the oedema is localized to the tonsils. A primary streptococcal laryngitis is rare, and is generally part of a pneumonia or is a direct extension from the pharynx. The epiglottis and arytenoids and soft tissues of the larynx become oedematous, and acute laryngeal obstruction may be expected. Alcoholic patients appear to be susceptible to this type of infection. Cervical adenitis is always present, and varies with the virulence of the infection. The more virulent cases show considerable swelling of the neck, Ludwig's angina, and may go on to suppuration. Though extensive adenitis means a severe infection, it also indicates a localization of the inflammation, and a general septicaemia is not so likely to arise. It has been noticed that when the tonsils have been enucleated, even some years before, the inflammation of the pharynx and the adenitis are more marked. Suppuration appears to be more frequent, but extensive adenitis occurs when the tonsils are present or absent.

Aetiology

The most common causal organism is the *Streptococcus haemolyticus*, which is found in the swab from the throat and in the severe septicaemic cases can be cultured from the blood. Streptococci and pneumococci are often found together in the normal throat, and both these organisms will often be present in septic conditions of the throat, so that it may be impossible to say which is the causal organism and which is the secondary invader, or there may be a mixed infection. R. G. Henderson has given a very useful account and summary of eleven cases of acute pneumococcal pharyngitis. I cannot do better than quote extensively from his paper published in the *Lancet*.³ The pneumococcal case can be recognized clinically, but it requires the bacteriologist to prove the infection, and the co-operation of the bacteriologist is essential when serum is to be given. The typical pneumococcal case is of rapid and sudden onset, sometimes with a rigor. The patient looks and feels very ill, and has a high temperature and rapid pulse. The early oedema and redness of the throat is followed by a greyish-yellow membranous exudate extending on to the pharyngeal wall and uvula. Pain and the resulting dysphagia are very marked; the cervical lymphatic glands are tender and swollen. In the

* Read in opening a discussion in the Section of Oto-rhino-laryngology at the Annual Meeting of the British Medical Association, Oxford, 1936.

early stage, before the membrane appears, it is impossible to distinguish the pneumococcal tonsillar and faucial inflammation from that due to the streptococcus. In all the eleven cases the pneumococcus was the predominating organism in the throat swabs and in ten the organism was found in the blood, showing a pneumococcal septicaemia. All the septicaemic patients did not respond to treatment and died rapidly. The case which recovered was a Type II pneumococcus; four cases were Type III, and six cases Type IV. Tracheotomy was performed on three patients, all of whom died. Anti-streptococcal serum and opothchen did not have any beneficial effect.

In analysing sixty-six cases of acute laryngeal obstruction in infants Bradford and Leahy⁴ found that thirty-eight were due to diphtheria and twenty-eight to the green streptococcus. In all the thirty-eight cases of diphtheria the bacillus was found, and the membrane was seen in thirty-one. In severe cases of diphtheria it is claimed that there is a mixed infection with the *Streptococcus haemolyticus*, but though the two organisms may be found together it is not known whether the streptococcus plays an active part.

Causal Factors and Epidemiology

Certain aetiological factors of streptococcal infections of the throat are well recognized. The spread of infection from one patient to another is perhaps the commonest. Small epidemics of tonsillitis are seen in residents, nurses, and students of a hospital. It occurs when a nose or throat operation is done during an epidemic of so-called influenza or of acute catarrhal infections, and it was particularly noticeable in the old pioneer days when a nose or throat operation case was admitted to a medical ward owing to the lack of provision of a sufficient number of beds for the ear, nose, and throat department. A severe streptococcal illness has resulted when a nasal or throat operation is done during or too soon after a bad cold or catarrhal infection, particularly too soon after measles. Sepsis following a nose operation has appeared as a severe streptococcal tonsillitis, and has sometimes led to other cases in the same ward—a strong indication that these cases should be isolated and certainly not be allowed in a surgical ward, and a plea for small wards of not more than ten beds, the rest of the floor being occupied by separate rooms and adequate balcony accommodation. There have been many epidemics of acute streptococcal throats traced to infected milk, and occasionally water, food, and feeding utensils. One of the best recent examples of milk infection is that of an epidemic at Brighton at the end of 1929.⁵ Patients were of all ages, but it was noticed that many of them were round about 60 and 70, and the epidemic was localized to Brighton and Hove. It took the form of severe follicular tonsillitis, frequently accompanied by the formation of a false membrane, or a second type of case was seen which resembled virulent diphtheria with a membranous exudate. Glandular enlargement was more marked than in ordinary tonsillitis, and in a few cases gland abscesses resulted. Relapses were common, presumably due to repeated doses of the infected milk. Septicaemic complications, such as pneumonia, peritonitis, nephritis, and arthritis, occurred in a few patients, but apparently otitis media was conspicuous by its absence. The source of infection was traced to one dairy. Several doctors made the observation that those patients who had had enucleation of tonsils were more severely infected than those whose tonsils were present.

Scarlet fever should always be remembered when a child is seen with a virulent tonsillitis and adenitis, particularly when it is accompanied by vomiting and there are other cases. There have been several epidemics of haemolytic streptococcal infection of the throat in schools which did

not resemble scarlet fever, but were ultimately proved to be an unusual and atypical form of it. A few sporadic cases of tonsillitis can be traced to bathing in polluted water. This type is generally a diffuse infection of the throat and nose, and otitis media follows. It is seen during a spell of hot weather when bathing pools are overcrowded. It is remarkable that these cases are so few; the resistance of the average bather must be high. Time will not permit me to indicate the methods now employed to prevent this type of infection. Small epidemics of severe tonsillitis have occurred among passengers in cruising ships, and it is difficult to trace the source of infection, which may be caused by water, food, the swimming pool, or spread from one patient to another. Some of the most severe streptococcal throats follow the extraction of teeth.

Treatment

Streptococcal infections of the throat, even when they appear as an ordinary tonsillitis, demand careful treatment, and must be regarded as serious. Skilful nursing, both day and night, is essential, and there is no illness in which the active co-operation of the bacteriologist, surgeon, and physician is so necessary to ensure a successful result. Swabs of the throat must be examined, blood cultures taken, and blood counts done. If there is any question of diphtheria serum should be given at once without waiting for the bacteriological report. On the other hand, it is useless to give anti-streptococcal serum if the infection is due to the pneumococcus. Blood transfusion and immuno-blood transfusions may be necessary. It appears to be universally accepted that anti-scarlatinal streptococcal serum should be given in large doses in streptococcal infections. Some find anti-diphtheritic serum of value even when the Klebs-Loeffler bacillus is absent. Felton's pneumococcal serum is suitable for infections due to the pneumococcus Types I and II, but only one of Henderson's eleven cases was due to Type II; the rest, all fatal, were due to Types III and IV.

The physician may be called upon to treat heart failure, pneumonia, etc. A calomel purge is a favourite start. The surgeon-laryngologist not only may have to deal with suppuration and abscess formation, and perhaps perform tracheotomy, but he has to relieve the patient of his distress and painful symptoms. Gargles are painful and of little value. The throat has to be cleaned by gentle swabbing with hydrogen peroxide, followed by spraying with a mild antiseptic solution made up with glycerin or paraffin. It is useful to spray the throat with a 1 per cent. solution of cocaine before swabbing, and before food or swallowing. The insufflation of orthoform and anaesthetin powder is innocuous and relieves pain. If the patient cannot sleep there is no objection to doses of morphine and atropine given hypodermically, provided there is no oedema of the larynx and no abscess which is likely to burst; Dover's powder or aspirin is also very useful. Hot applications in the form of an electric heating pad to the neck, or the inhalation of steam in the form of friars' balsam, are comforting. I have found a mixture of potassium chlorate and sodium salicylate helpful, and it has a beneficial effect on the adenitis. The patient should be encouraged to take as much fluid as possible, and intravenous glucose by the drip method is of undoubted benefit. Various bactericidal compounds are disappointing. Professor Horlein has advocated the use of a dye compound, prontosil, which is said to render streptococci more susceptible to phagocytosis.

Complications

The complications of the acute streptococcal infections of the throat are numerous, particularly in cases of a septicaemic nature. The throat condition may also be a

part of a general infection. Lemierre has described cases of septicaemia due to anaerobic organisms occurring in young adults, sometimes in small epidemics, in which the most usual initial cause was a tonsillar or peritonsillar abscess opened too late or to an insufficient degree. These septicaemias are considered to result from a thrombophlebitis of the tonsillar and peritonsillar veins, which can spread to the internal jugular vein or even the facial vein. The first sign of septicaemia is a rise of temperature to 102° F. with a rigor, usually on the fourth or fifth day after the initial sore throat. The rigors may be repeated daily, and adenitis is often severe; the *Bacillus fundibuliformis* may be cultured from the blood. Septic infarcts and arthritis arise, and the organism can be found in the metastatic abscesses. Certain German observers⁷ have ligatured the jugular vein on the side of the affected tonsil as soon as the clinical diagnosis was possible, and without waiting for the result of the bacteriological examination. They claim that ligature of the vein has diminished the mortality. Lemierre⁸ had one case in which the jugular vein was ligatured, but it did not prevent a fatal termination. For the sake of brevity only those complications which concern the laryngologist will be mentioned.

1. Abscess formation in connexion with the tonsil, which is of better prognosis than a cellulitis without suppuration. The usual supratonsillar fossa abscess deep to the upper pole of the tonsil is opened and drained by a crucial incision, but when the abscess is deep to the lower part of the tonsil, or a posterior tonsillar abscess deep to the lateral wall of the pharynx is present, further operative treatment than incision may be required.⁹ A total enucleation of the tonsil has been done.

When repeated incisions have failed to find pus, and when drainage is not good in a patient who has a high temperature and whose general condition is unsatisfactory there may be:

2. A general infection with haematuria, albuminuria, oedema of the larynx, thrombosis of the jugular vein, and general sepsis.

3. The presence of either a parapharyngeal abscess in which the pus has tracked into the deep fascial planes of the neck, or suppuration of a lymphatic gland.

When the abscess or cellulitis occupies the central fascial compartment near the carotid vessels, violent and fatal haemorrhage has occurred as the result of erosion of the jugular vein or carotid arteries. Erosion of the jugular vein is said to be more common in scarlet fever.

TONSILLECTOMY

Tonsillectomy during the acute state is not popular because it is not without risk, and there is the danger of a considerable increase in sepsis. Haemorrhage at the time of the operation and after is severe, and difficult to control; the tonsillectomy is also difficult, and often inefficient and incomplete. Local anaesthesia is advisable, and if employed the operation may be painful owing to lack of infiltration of the anaesthetic solution. Canagt¹⁰ and Reidar Schroeder prefer to dislocate the upper pole of the tonsil or to remove it—that is, do a partial tonsillectomy and so drain the abscess. This is followed a few days later by tonsillectomy in the tepid or cold state. It has the advantage of allowing the surgeon to pack the cavity behind the tonsil in cases of haemorrhage. The injection of a local anaesthetic through the anterior pillar just above the last mandibular molar abolishes trismus. Schroeder of the Sundby Hospital, Copenhagen, states that of 148 tonsil abscess cases ninety-two were treated by incision and required no further operative treatment; fifty-six were treated by further operation; in fifteen no pus escaped on incision and the temperature remained high; thirteen had nephritis; eleven oedema of the

glottis; seventeen lateral pharyngeal or posterior tonsillar abscess; and there were two cases only of lateral sinus thrombosis.

Total tonsillectomy has been performed to arrest haemorrhage resulting from a tonsil abscess. The internal carotid artery and the jugular vein have been eroded by tonsillar and gland abscesses. Such a catastrophe demands a bold and prompt decision, and still more rapid ligature of the eroded vessel. This fulminating haemorrhage is more common in cases of posterior or lateral retropharyngeal abscess and in children. In this country, except in cases of haemorrhage, there is little opportunity of enucleating tonsils during the acute stage of tonsil suppuration, but it must be remembered that a large number of successful cases of total enucleation of the tonsil during the acute stage have been recorded.

CERVICAL ADENITIS

Cervical adenitis is nearly always present during a streptococcal infection of the pharynx, and in a number of cases suppuration has followed. The glands should never be incised before it is reasonably certain that an abscess is present. Too early incision does more harm than good. Abscesses in the neck arise by suppuration of lymphatic glands or by direct extension from the tonsil through the pharyngeal wall, or they are blood-borne, in which case there will be thrombosed veins. The pus is usually found in the visceral or central fascial compartment along the carotid sheath, or in front of the styloid process and its muscles deep to the submaxillary gland. More rarely the glands in front of the trachea near the isthmus of the thyroid gland suppurate. Some abscesses tend to point at the posterior border of the sternomastoid. An abscess in the central compartment has led to fatal mediastinitis. When an abscess is present it should be freely opened with a knife with as little trauma as possible—that is, a careful dissection should be made down to the abscess, which is often deep to the muscular planes, and any loculi gently broken down with the finger. The finger is a better instrument than a sinus forceps. Free drainage should be established by a well-planned incision and counter-incision rather than by thrusting in a drainage tube. Epidemics of acute streptococcal adenitis have occurred in children during the influenza season.^{11 12} The illness commences with a high temperature, rigors, and a diffuse adenitis, and very little can be found in the throat beyond a slight diffuse catarrh; a very few cases of acute tuberculous adenitis in young children have been known to be similar in onset; a swab reveals a haemolytic streptococcus. Blood culture is negative. The acute stage of the illness appears to be over in about ten days, but relapses with a high temperature are frequent, and the illness is prolonged from four to five weeks. Complications such as bronchopneumonia, nephritis, and otitis media have been recorded; suppuration is uncommon. Anti-streptococcal serum has no beneficial effect.

OEDEMA OF THE LARYNX

Oedema of the larynx accompanies the fulminating types of infection of the throat, particularly when the epiglottis and arytenoids are involved. An inspection of the larynx should always be made, and a careful watch for oedema should thus be a routine. At the first sign of any laryngeal involvement tracheotomy instruments and a syringe charged with a local anaesthetic should be at hand. If the patient is not on the same floor as the operating theatre a table and sandbag should be placed ready in the room, with a good light. Laryngeal obstruction is often rapid and dramatic in its onset, especially if there is any heart failure, which adds to the oedema. These fulminating cases in which tracheotomy has to be per-

formed are nearly always fatal, in spite of the relief of the laryngeal obstruction. Every effort should be made to avoid tracheotomy, but delay is sometimes dangerous.

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THE HAEMOLYTIC STREPTOCOCCUS: WITH SPECIAL REFERENCE TO SCARLET FEVER*

BY

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I appreciate with real sincerity the honour of your invitation to open this important discussion, for you know that I have nothing new to tell you; I can claim to know nothing of the subject which is not better known to many of you, and very little which is not known to all. So the fruitfulness of this meeting will rest not upon what I say but upon what you say, and my task is the easy one of getting you going.

We are about to discuss one of the most important subjects in medicine, for to the European the streptococcus is public enemy No. 1, and deep down in the minds of all is the conviction that we ought to be able to circumvent it. We have given up the idea of exterminating, or incarcerating it, but we believe, with much reason for our belief, that we can manage to make it live amongst us as a respectable citizen.

Forty years ago I gained a prize for an essay on the streptococcus which covered a full sheet of foolscap! Since then knowledge of the varieties and attributes of this organism has grown so much that in the *Annals of the Pickett-Thomson Laboratory* it commands eight large volumes; the literature dealing with it and what it does to man would fill a respectable library. But recently those streptococci which interest us have been found to be of more manageable proportions, and from Dr. Dora Colebrook's report, which is the latest word on the subject, we can reduce the varieties of streptococcus important to human pathology to some dozen or so.

Although during the past fifty years there has been a dramatic decline in the prevalence and fatality of the acute diseases, the ravages of the streptococcus have increased. Alone of all the important causes of death, fatal streptococcal infection shows an increase which is exalted on standardization. But it is not only as a lethal agent that the streptococcus is important to us; it is the commonest of all causes of temporary inconvenience, and also of permanent defection from normal health. Probably nobody in temperate climes passes through life without paying some tribute to the great enemy; none of us knows when he may next be called upon for a contribution, the amount of which cannot be foreseen. We in this room can have some assurance that we shall not suffer from most of the diseases caused by parasites, but from those due to the streptococcus we have none, yet it is in the minds of all of you, as it is in mine, that this ought not to be; that the

enemy is not so elusive that it is beyond our powers to keep it at bay. So far we have failed, but our failure has been by no means complete. In many ways what has disappointed us opens up new hopes of an eventual success greater than any we have visualized in our limited endeavours of the past.

Varieties of Infection

The diseases caused by the streptococcus fall into two groups: (1) the three notifiable diseases, scarlet fever, erysipelas, and puerperal fever; and (2) a miscellaneous group embracing almost every form of sickness from which we suffer. But multifarious as are the manifestations of streptococcal infection, they are all so similar fundamentally that the clinicians preceded the bacteriologists in separating them from sicknesses caused by other parasites. Any and all of the forms of disease dependent upon streptococcal infection can be caused by any or all of the varieties of the parasite known to be pathogenic to man, though in certain types of lesion certain varieties of parasite are more frequent than others. From this it would seem that our attack upon the streptococcus must be generalized, though without doubt we must employ many different arms to win the battle.

The reservoir of the haemolytic streptococci pathogenic to man is the human nasopharynx; elsewhere it is found only in lesions caused by it. Epiphytic streptococci found on other parts of our surface are not pathogenic, nor are streptococci from extra-human sources, unless these have been recently distributed from a human carrier. The pathogenic varieties are found in from 1 per cent. to 100 per cent. of healthy pharynges according to season, period, and locality. It is questionable whether they are more frequent in unhealthy or convalescent throats than in healthy throats. They can, of course, always be found in the throats of scarlet fever and streptococcal tonsillitis patients, and for a short time after the reaction has subsided, but I doubt if true carriers are more common in those who have reacted than in those who have not. By a healthy throat I mean one which functions sufficiently to enable its possessor to get about his business without knowing that he possesses a throat, unless he thinks about it. In the prevention of massive infection, three things stand out clearly—the use of masks in surgical operations, even of a trivial character, and in midwifery; the relative isolation of those likely to be discharging the parasites profusely; and the adequate spacing of all sick persons, especially of those suffering from sicknesses in which an added streptococcal infection is most to be feared. These are old measures, sound in theory, and of proved efficiency in experience.

The virulence of the pathogenic streptococci appears to be exalted by passage through a host for other hosts similarly circumstanced. This is most obvious in localized outbreaks of puerperal fever and erysipelas, but is seen in all streptococcal diseases—for example, in peritonitis following clean operations. This exalted virulence seems to be specific. It is evidenced by shortening of the incubation period, rapid invasion of the tissues, and heightened fatality. In outbreaks of puerperal fever the virulence is enhanced mainly, if not exclusively, for puerperal women, not for their attendants.

During the last few years I have had the opportunity of studying the interaction of scarlet fever and the puerperium and have formed the following conclusions—at present held tentatively.

1. Parturient women are just as likely to suffer from scarlet fever as are non-parturient women.

2. If the implantation is at the normal site—the throat or nose—both scarlet fever and puerperium run their normal courses.

* Read in opening a discussion in the Section of Public Medicine at the Annual Meeting of the British Medical Association. Oxford, 1936.