A CLINICAL STUDY OF ACTINOMYCOSIS, WITH ILLUSTRATIVE CASES.

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Definition.—By actinomycosis we designate a condition of chronic inflammation consequent on infection with a form of streptothrix which at some time or other in its evolution in the tissues leads to the formation of characteristic small granules composed of the fungus. Whilst recognizing that there may be many kinds of streptothrix which are pathogenic to human beings, we believe it a wise proceeding to retain the above term in addition to the more general term streptothrichosis, for there is accumulating evidence to show that the great majority of cases in man are due to one specific variety of infecting organism.*

Frequency.—Actinomycosis is known to be a common disease in cattle, but is usually regarded as affecting man infrequently. Judging by the general expression of opinion in this country, one would conclude that it was at least something of a rarity. Statistics collected in 1912 showed that during the ten previous years a total of 136 cases were admitted to the wards of seven of the largest hospitals in London; this number is very small, and would at first sight appear to support the view that the condition is comparatively rare. But analysis of the statistics reveals the striking fact that, whilst the four largest hospitals together only reported a total of fifty cases for that period, two of the smaller hospitals admitted respectively sixty-one and twenty cases. Though it would be unfair to draw any far-reaching conclusion from these figures, they seem to support the view that the discovery of the disease depends upon keenness of search, for chance alone could not account for the great discrepancy in numbers at the different hospitals in the same city. Indeed there can be little doubt that the disease is much more common than English teaching allows. The ordinary routine of out-patient work furnishes a sufficient number of cases to make it incumbent upon the surgeon *always* to consider actinomycosis as a possibility in any chronic lesion. During the last three and a half years I have had under my care at least thirteen cases, and it is significant that by realizing some of the earlier signs of the condition, and making a routine examination for the fungus in chronic lesions, the number of cases has relatively increased; it cannot be doubted that previously cases were missed for want of sufficient investigation, or even because the very possibility of certain lesions being actinomycotic was not considered.

* The published investigations of Woolf and Israel and of Homer Wright, and the recent unpublished researches of Colebrook, all point to this conclusion. So far as I am aware, Foulerton's work has not been confirmed, and the series of cases here presented lend little or no support to his views.

Source and Mode of Infection.—The fungus of actinomycosis is parasitic on, or has close connection with, certain cereals and grasses. It is not surprising, therefore, that herbivora, especially oxen, are prone to the disease. Most frequently it attacks the region of the lower jaw, and forms a very hard, tumour-like mass; sometimes it causes the 'wooden tongue' in cattle. It is unlikely, however, that human beings are often infected direct from cattle, for a large number of those who get the disease give no history of contact with animals. We can dismiss the theory that infection may be conveyed by tainted meat, on the grounds that very little infected meat is likely to pass the inspectors, and that cooking would certainly destroy the streptothrix. Nevertheless, undoubted cases of infection from living animals have been recorded, and one must therefore allow that this mode, though rare, is possible. Infection may occur direct from the vegetable which harbours the parasite. A lad (whose case is recorded below) tried to swallow a blade of grass, which stuck in his tonsil and formed an abscess which was lanced from inside the mouth. A month later an abscess formed at the angle of the jaw, from which actinomycotic granules were obtained, and from which a few days later the blade of grass escaped. Direct evidence of this kind is not as a rule forthcoming, nor do many of the patients tell of any habit of carrying bits of straw in the mouth. We must then look for some more generally applicable mode of infection.

The skin is not commonly affected primarily, so for practical consideration as to the mode of ingress of the fungus into the body there remain the alimentary and the respiratory passages. Infections in the region of the mouth are more numerous than all other cases put together. As contributing causes to this notable fact, we must remember (*a*) that the mouth is the part which first receives food, with any concomitant bacteria; (*b*) that there are many recesses and crevices around the teeth and in the tonsils which readily harbour microbes and sufficient particles of food to provide them with pabulum; (*c*) that the process of mastication provides many opportunities in the way of minute abrasions of mucous membrane for the fungus to enter the deeper tissues.

No one who has observed cases of peri-buccal actinomycosis can have failed to be struck by the association of carious teeth with the disease. Débris most readily collects around such teeth, especially in those who do not attend to dental hygiene. Some observers have demonstrated the presence of streptothrix in such débris. The intimate relationship between carious teeth and the disease is clearly shown in *Cases 6 and 7* related below. In *Case 7*, the removal of a carious tooth allowed a probe to be passed easily into a large cystic cavity in the lower jaw which was filled with actinomycotic pus.

A case recently under my care gave most striking clinical confirmation of the theory of infection from carious teeth. During a fight with another man, a patient knocked out his opponent by a hard blow on the upper jaw. His fist struck against the other man's teeth and knocked some out, and a small superficial wound on the back of the hand was thereby caused. Inflammation ensued, and, after an acute stage, passed into an indolent condition. When first I saw the case there was considerable infiltration in the first

intermetacarpal space; from the discharging pus actinomycotic fungus was obtained.

The question as to how the fungus is conveyed to the mouth should not be difficult of answer. Many articles of diet are commonly packed in straw and eaten uncooked. Fresh fruit such as is usually eaten raw must be exposed to the risk of contamination from grass and straw in its conveyance from the field to the consumer. So it may be assumed that the streptothrix has many opportunities of access with ordinary food, and one need not invoke any habit of straw-chewing or grass-eating in most cases. It is clear, however, that those who live in the open country, and those in cities whose occupations entail the handling of hay or straw, are more exposed to infection. Gardeners, stablemen, fruiterers, warehousemen and packers, carmen, and carpenters would be amongst those more liable to the disease, either by direct digital contamination of food or by aerial transmission of the fungus.

The other parts of the alimentary tract from which infection may occur are the pharynx, œsophagus, and the cæcal region.

There are many arguments to support Poncet's view that the thorax is frequently infected by way of the œsophagus. For example, there is frequently a long interval at the commencement of the disease in which no pulmonary symptoms are noted, and it is at a late stage that the fungus is discovered in the sputum. Again, the location and mode of spread of the disease is suggestive of its origin from the mediastinum. Radiographs showing the earlier stages, and autopsies held on advanced cases of the disease, are both in keeping with this view. The way in which the process tracks back into the paravertebral groove or forward through the chest wall at the attachment of the diaphragm is easily explained if we adopt the theory of œsophageal infection. It is not sufficient evidence against this view that few œsophageal lesions are discovered, for in many undoubted cases of mouth-infection no lesion can be discovered in the buccal cavity at the time the disease comes under observation.

Infection from the stomach and small intestine is almost unknown. The acid gastric juice would either kill the fungus or inhibit its activity, whilst the fluid contents of the small intestine are unlikely to produce any abrasions through which the streptothrix might escape. In the cæcum, however, there is stagnation of the intestinal contents, and great multiplication of the bacterial flora, which from time to time assault the lining mucous membrane. An acute attack of appendicitis or typhlitis readily gives the opportunity for which the actinomycotic organism is waiting, and the latency of some forms of catarrhal appendicitis, which would nevertheless be sufficient to provide a mode of egress of the fungus into the tissues, may account for the extreme insidiousness of onset of some cases of actinomycotic appendicitis.

That the respiratory passages also provide an occasional path of entry, by means of spores or minute portions of mycelium floating in the inspired air, is indisputable; for cases are reported in which the lesions were confined to pulmonary tissue. These cases would be more likely to simulate tuberculosis of the lungs, and hardly come within the province of the surgeon.

CLINICAL PATHOLOGY.

Tissues Attacked.—The streptothrix of actinomycosis in a striking manner attacks some tissues in preference to others. Its best growth is seen in the connective tissues, especially subcutaneous, submucous, subperitoneal, and subpleural. The process extends nearly always by continuity in the

FIG. 13.—TEST-TUBE CONTAINING A LITTLE ACTINOMYCOTIC PUS, which has been poured down the side of the tube. Note the small granules which have stuck to the glass, and observe that no granules can be seen in the pus at the bottom, since there is nothing to contrast them against.

FIG. 14.—TEST-TUBE CONTAINING ACTINOMYCOTIC PUS MIXED WITH BLOOD (derived from the contents of the jaw abscess in Case 7), demonstrating how the yellow granules may show up against the general red ground.

connective tissues, seldom by the blood-stream, and hardly ever by the lymphatic system. Muscles are either pushed aside or infiltrated. Nerves may or may not be irritated by the disease. Bones may be superficially eroded by a contiguous focus. Primary bone infection is only seen in the jaws.

The skin is nearly always involved sooner or later, but offers greater resistance than the underlying tissues, for although sinuses develop, they show a tendency to close up before the underlying focus is extinct, and there is seldom much loss of skin leading to the formation of an ulcer. Possibly the preference of the organism for anaerobic conditions may partly account for this.

The lymphatic system is curiously immune to attack. The lymph glands are not enlarged, and do not appear to react in any way against the fungus. This fact serves to distinguish actinomycosis from other forms of infection, and especially from tubercle.

The peritoneum is resistant to attack; large masses of diseased tissue may form behind the peritoneum and bulge forward into its cavity without the serous lining permitting any to pass through; the retroperitoneal extension may be as far up as the diaphragm and as low as the pelvic muscular floor. When drainage of an actinomycotic abscess is carried out across the peritoneal cavity, the track of the tube becomes infiltrated with the disease, but peritonitis does not follow.

The course of the disease in the thorax lends support to the opinion that the pleura offers considerable resistance to the extension of the infection. The parietal abscess usually comes to the surface somewhere along the line of the attachment of the diaphragm, as though it had tracked along under the pleura. In one of the cases under my care (*Case 10*), thoracic infection was preceded by an empyema which left a large cavity that showed little attempt to heal up. When in a few months actinomycosis developed on the same side of the chest, it came to the surface underneath the left breast and in front of the cavity left by the empyema; the fungus did not break through the pleural wall of the empyema, and no streptothrix was obtained from the sinus.

Cases of primary actinomycotic infection of the genito-urinary system have been recorded, but are so rare that they must be regarded as curiosities.

Transmission by the blood-stream sometimes takes place, and metastatic abscesses have been found in the brain and kidney, etc.

Reaction of the Tissues.—When the streptothrix of actinomycosis grows in the tissues, it forms masses of mycelium of varying size—the granules of actinomycosis. These may be as large as a canary seed, or so small as hardly to be seen by the naked eye. The colour of the larger granules is often a mustard-yellow, but the smaller may be white, pinkish-grey or grey, or very pale yellow. *They can very easily escape notice when mixed with blood or liquid pus.* A good way to detect them is to allow the pus to flow down the sides of a sloping test-tube, for the granules adhere to the side of the tube, whilst the fluid part collects at the bottom. If the tube is held against a dark background the minute specks show up more readily (*Figs. 13, 14*). A magnifying glass may sometimes be used with advantage in their identification. The presence of the fungus in the tissues excites a reaction of varying intensity. In some cases the rapid growth of the streptothrix utterly disorganizes the

surrounding parts, which react by the formation of soft vascular granulation tissue. In other instances there is a characteristic formation of very dense fibrous tissue, which on section is almost cartilaginous in density. It may be possible to examine many sections of this tissue, both with the naked eye and under the microscope, without detecting any sign of the fungus; but if left alone, softening always occurs at one or more spots in the swelling, and the fungus may then be found in the softened area.

Vascularity of Lesions.—The vascularity of the lesions depends upon the nature of the tissue-reaction. In the soft variety there is a good blood-supply, but in the harder type the blood-vessels appear to be strangled by the contraction of the new fibrous tissue, so that the parts become avascular.

The Pus.—The only characteristic feature of the pus is the presence of the granules, and even these are not to be found at every stage of the disease. When the granules are very small and there is well-marked secondary infection, the pus as it escapes may appear just like that which comes from an ordinary abscess infected by staphylococci or other septic organism, whilst at other times, incision of a softened focus may not lead to the discovery of any true pus, but only a mixture of blood and granules. Sometimes the pus has a foul odour. When a large soft focus is opened, it presents a very characteristic appearance owing to the innumerable little yellow granules forming a sort of network throughout the soft flabby granulation tissue; it is as if canary seeds had been sprinkled through the vascular mass, which has the consistency of a soft fungating cancer. The term *encephaloid* might suitably be applied to such tissue.

Regional Distribution.—The regions attacked by actinomycosis may be grouped as follows:—(1) *Upper alimentary canal*: bucco-pharyngeal forms; (2) *Lower alimentary canal*: cæcal and appendicular infection; (3) *Thorax*; (4) *Miscellaneous*: skin, genito-urinary, etc.

CLINICAL SYMPTOMS.

The clinical symptoms vary considerably in different parts of the body, but in most cases two stages can be recognized: (a) The stage of induration; and (b) That of softening. Though the process is occasionally acute or subacute at the onset, it is essentially of a chronic nature.

1. The Upper Alimentary Canal.—The bucco-pharyngeal region is by far the most common to be infected primarily. This is not surprising, since any fungus introduced along with the food would here first have a chance of entering the tissues; the minute traumata caused by mastication would furnish frequent opportunities. Lesions may be found in almost any part abutting on the mucous membrane of the mouth and pharynx—the cheek, the parotid region, the submaxillary region, the tonsil, the tongue, the lower jaw, or the lower parts of the neck in relation to the pharynx. The upper jaw is rarely affected.

The site of development depends upon the place of inoculation; but though the latter is nearly always from the mucous side, the infective process, if occurring in soft tissues, generally spreads outwards towards the skin by the shortest or least resisting line of connective tissue.

When the tonsil is the path of infection, the process spreads downwards and backwards underneath the parotid gland till a swelling is formed in the interval between the angle of the jaw and the mastoid process. Possibly the stylo-maxillary ligament helps to prevent extension in other directions.

If infection takes place through the gums or teeth of the lower jaw, there may result a small induration on the outer aspect of the horizontal ramus, or a more extensive condition involving the cheek and parotid region—the most typical form of actinomycosis.

The lower jaw may be the seat of a primary focus which starts by the entry of the streptothrix through a diseased tooth socket. Submaxillary infection is undoubtedly in some cases the result of the fungus gaining access along Wharton's duct, but it is most likely that the more common mode of entry of the organism is through the mucous membrane of the floor of the mouth or alveolar margin. Infections lower down the neck, when they are not the continuation of a process which started in the buccal area, most likely track direct from the pharynx.

In most cases it is impossible to demonstrate any breach of the mucous membrane through which the fungus might have entered, but it is frequently found that carious teeth are near to the region affected. In younger persons with perfect teeth, an opportunity of entry for the fungus may be furnished by the eruption of a tooth (*Fig. 15*). One observer has noticed that the eruption of the wisdom teeth is of special importance in this connection. I have had one patient in whom the disease developed near the wisdom tooth at the time of its eruption, and I have seen another in whom I blamed the second lower molar eruption for the starting of the condition. In slight cases of the disease, a limited smooth hard swelling may form in relation to the jaw, and within two or three weeks break down into an abscess. In the worst cases the induration is excessive, and a large mass of tissue as hard as wood may persist for a year or so with very slight softening. Most commonly the induration stage lasts for two to four months before softening is apparent.

There is generally much less swelling on the inside of the cheek or jaw, and it is rather uncommon for sinuses to open on to the interior of the mouth. Pain is most often relatively slight, and is altogether absent in the very chronic cases with marked induration. It is a marked feature, however, of the early subacute stage of the type which invades the parotid region. When a hard painless focus takes on a more rapid growth with softening, pain may be complained of.

FIG. 15.—PHOTOGRAPH OF PERI-MANDIBULAR ACTINOMYCOSIS, which began about the time of eruption of the second permanent lower molar tooth. After causing a firm swelling for about three months, the process softened and discharged granules through a small sinus near the outer canthus of the eye. (*Under the care of my colleague, Mr. Maynard Smith, by whose kindness I was permitted to have the photograph taken.*)

Owing to the conditions of growth of the organism and the resistance which the skin offers to it, ulceration is seldom seen except in those cases where the surgeon has removed a considerable amount of the diseased tissue along with the overlying skin; in that case the raw surface shows little tendency to epithelialize over, unless quite healthy tissues form the base of the ulcer.

Secondary infection is common. The mouth contains many varieties of bacteria, and these frequently gain access to the tissues at the same time as the streptothrix. It is quite possible, and even likely, that septic organisms may in some instances prepare the way for the fungus of actinomycosis, just as we know they help the implantation of tetanus bacilli. Certainly they may give a much more acute character to the malady, and cause it to be mistaken for a mere septic infection. In the greater destruction and liquefaction of tissues which ensues with septic infection, the fungus may be difficult to find, and often appears degenerated and fragmented. The cellular tissues, however, can usually defend themselves against pyogenic microbes, and if the resulting abscess be drained adequately, the lesion subsides. But when the actinomycotic element is present also, the removal of the septic factor may allow it to grow in more typical fashion. Cases are undoubtedly missed because the initial examination of the pus may show a preponderance of other bacteria.

The skin over a buccal actinomycotic focus is usually unaffected for some time. The surface is smooth and the colour normal, or rather paler than normal, owing to the stretching of the superficial parts. A week or so before an abscess is going to burst, the skin becomes bluish-red or red, and fluctuation is obtainable.

A short description of that form of the disease which causes a swelling of the side of the face and the region of the angle of the jaw will serve to illustrate the main features of the condition as shown in one of its most common sites. The term cervico-facial as applied to it indicates the region affected; in many cases cervico-parotid would be more precise.

Clinical observation leads us to the belief that this form has its origin, in the majority of cases, through an entry of the fungus into the connective tissues of the gum near the lower molar teeth. In some cases the only abnormality discovered inside the mouth has been a carious lower molar or its stump. If the accompanying sketch of the vertical coronal section of the cheek and jaw region (*Fig. 16*), kindly drawn for me by Professor Frazer, be studied, it will be apparent that infection could readily extend into the cheek from a carious tooth which was worn down almost flush with the gums. The diagrams (*Figs. 16, 17*) also demonstrate the important fact that the cellular tissue of the cheek is more abundant, and has closer relationship with the alveolar margin of the jaw, than the similar tissue on the inner side of the horizontal ramus. This may account for the undoubted clinical fact that the actinomycotic process seldom extends much on the inner aspect of the jaw, but spreads freely throughout the cheek. We believe infection along the parotid duct to be a much rarer path of infection.

Cervico-facial actinomycosis is characterized by a swelling of the cheek which extends from the zygoma above to the inferior border of the mandible

below, and from the ear to the anterior border of the masseter. If it starts acutely or subacutely, the swelling during the first week is more diffuse and painful; pain is complained of in the region of the molar teeth and in the ear, and there may be tenderness on firm pressure over the swelling. When the process is chronic from the start, pain may be completely absent. In all cases, within three or four weeks a firm swelling is formed which has its maximum at the junction of the horizontal and ascending rami of the jaw. A marked symptom at this stage is trismus. The patient may not be able to open his teeth more than half an inch, and pain may be experienced in attempting to do more. The further course may be one of progressive hardening or softening. If the former, the swelling gradually indurates, and at the same time extends, till in

FIGS. 16 and 17.—VERTICAL AND HORIZONTAL SECTIONS THROUGH THE CHEEK AND PERI-MAXILLAR REGIONS, to show the close relationship of the lower molar teeth to the cellular tissues of the cheek. Opposite the second and third lower molars the groove between the cheek and the alveolus becomes so shallow that involvement of the soft tissues of the gum would very readily lead to implication of the corresponding part of the cheek. Further forward there is not the same likelihood of this.

(I am indebted to Professor Frazer, who kindly modified these for me from illustrations in his book.)

a few months the whole of the cheek, the parotid region, and the tissues over and below and behind the angle of the jaw form one solid mass of almost wooden consistency. The surface is smooth and forms a segment of a sphere, and pain is now neither complained of nor elicited on pressure. There is hardly anything in the range of surgery which has more characteristic features than such a swelling. The indurated mass sooner or later—after a time varying from two to four months—softens at one or more spots.

Softening nearly always occurs at the lower and posterior limit of the mass near the angle of the jaw, but occasionally it may be noticed at the upper limit near the zygoma or the eyelids. The resulting sinus discharges pus containing granules of the fungus. If the soft area be incised before the

abscess points definitely, no pus, but only blood and granulation-tissue debris, may be obtained. Aspiration by a needle is unlikely to draw off material of much use in diagnosis, because the granules of the fungus would have difficulty in traversing the needle.

A gradual migration of the inflammatory process towards the neck is noticeable. The path traversed is that of the subcutaneous connective tissues, for the deeper parts are not commonly invaded. The travelling border is of the soft type, and induration is rare at the advancing margin. New sinuses readily form in the new soft tissue, and frequently the old ones close up. Since there is considerable destruction of the subcutaneous tissues, the resulting scars are puckered. When several of these scars have been formed, the cervico-facial area presents a very characteristic appearance which is figured in some text-books. This represents, however, a late stage of the disease, often four to six months after the onset. Sometimes, but more rarely, the process tracks up to the temporal region, and a hard mass may infiltrate the temporal fossa.

Palpation of the interior of the cheek gives a better idea of the anterior limit of the disease, for it can be felt much more easily under the soft mucous membrane. The induration sometimes has a clear-cut anterior border which ends abruptly just in front of the anterior edge of the masseter. In extensive cases the soft parts on both sides of the ascending ramus of the jaw are swollen and hardened, but involvement of the tissues on the inner aspect of the jaw must be accounted rare.

The inferior maxilla may be affected, either primarily or as an event secondary to the form above described. The process in the bone corresponds to that in the soft tissues. The indurated form is represented by a chronic osteitis with much formation of firm cancellous bone traversed by small sinuses of soft tissue. The soft form is represented by a rarefying osteitis which may lead to a superficial erosion or to a central abscess. That variety which leads to the formation of much new and rather dense cancellous bone is accompanied by an affection of the soft tissues overlying the jaw. The course taken by the rarefying type of the disease varies considerably. In some cases the bone softens rapidly, and a track or sinus is soon formed which may burst through on to the cheek or gum; in others a very gradual expansion of the bone occurs, and new bone is formed on the outside as the softening destroys it on the inside. In the latter instance a large cystic swelling of the jaw develops after a period of many months. This swelling is firm, but as the expansion becomes more marked, egg-shell crackling may be elicited on firm pressure. A radiogram will show the cavity to be in intimate relation to the root of a carious tooth. In many cases where the situation and hardness of the swelling might lead one to think the mandible was involved, such is not the case. The upper jaw is still more rarely involved.

Though the tongue is very commonly the site of actinomycosis in cattle, it is rarely affected in men. A small firm nodule may develop, soften, and discharge granules. It has been asserted that healing occurs more readily in this region than in other parts.

2. The Lower Alimentary Canal.—From a surgical point of view appendicular and cæcal infection is the variety next in importance to the bucco-pharyngeal forms.

Clinically, two types can be recognized, which differ one from the other chiefly in the mode of onset.

The acute form starts with an acute attack of appendicitis, with perforation or gangrene of the appendix. Operation will not show anything atypical in the attack; the appendix is removed or an abscess drained in the usual way; but the sinus left by the drainage tube shows no tendency to heal up. As the weeks go by, induration of the walls of the sinus is observed, and if the iliac fossa be palpated, a firm swelling can be felt in relation to the cæcum. The indurated walls of the sinus can be felt to be continuous with the deep-seated mass. At this time it is possible the surgeon may explore the sinus to determine if there be any locked-up pus or a concretion or minute faecal fistula to account for the condition; but he will find only a mass of firm tissue with softer parts in which dirty yellow specks may be seen. These specks are actinomycotic granules. Sometimes scraping the sinus will reveal them.

The chronic form, with insidious onset, first comes under the observation of the surgeon as a firm painless swelling in the right iliac fossa. Although no pain is felt locally, the infiltration of the adjoining iliopsoas may irritate the lumbar plexus, causing pain to be referred down the thigh. Persistent flexion of the hip may also result. The chronic pain in the thigh, with total absence of pain locally in the abdomen, can very easily mislead the observer. On exploration, the iliac swelling, in addition to hard tissue, will be found to have a softer nucleus containing actinomycotic granules. The soft material can be mistaken for the pus from an ordinary appendicular abscess which has become inspissated. The infiltration is retroperitoneal and may involve the psoas muscle deeply.

A third and pathologically interesting type is that in which the appendix, which has been removed for acute inflammation (without perforation), is found on examination to contain the fungus of actinomycosis. The acute inflammation is probably always caused by other organisms, and it is only when the wall of the appendix is perforated and the streptothrix has got into the cellular tissues, that one is justified in saying that actinomycosis is the dominant condition.

The further course of both main types is similar. The infecting process spreads slowly along the connective-tissue planes under the peritoneum; it may reach from the midriff to the pelvic floor. Large masses form in the loin and behind the ascending colon, pushing the latter structure forwards. Softening proceeds more rapidly in the newly-formed tissue, and abscesses need to be opened. Occasionally the process spreads under the peritoneum of the anterior abdominal wall as far as the umbilicus. Secondary infection is always present, and an irregular fever is the rule. The patient becomes markedly anæmic, and in fatal cases death occurs from exhaustion about a year after the condition has been detected. Recovery is always slow in the favourable cases.

3. The Thorax.—Apart from extension from the cervical region, there are two types of thoracic infection to be noticed. The first concerns only the air-passages, and gives rise to symptoms of bronchitis, or possibly bronchiectasis, in which the sputum may be foetid; this form comes under the care of the physician. The second or perforating type is attended by much infiltra-

tion of the connective tissues of the mediastinum, and later of the thoracic wall; at the same time the lung—nearly always the lower part—may be extensively invaded by the disease. Cavities may form, and the condition simulate closely pulmonary phthisis. An abscess comes to the surface somewhere in the lower part of the chest, and on incision the fungus can be obtained from the pus. We have stated above our belief, founded on clinical grounds, that this variety is usually of œsophageal origin; it is the form which is likely to come to the surgeon for treatment on account of the superficial abscesses. Perforating thoracic actinomycosis is always of the soft type; the absence of any induration may be due to the great vascularity of the parts affected. Sooner or later, large tracts of the lung, pleura, and chest wall become infiltrated. Secondary infection is common. Lung symptoms are usually absent at first, and the first sign of anything seriously wrong may be a fluctuant

FIG. 18.—PHOTOGRAPH OF A CASE OF ACTINOMYCOSIS OF THE LEFT CHEEK CHIEFLY AFFECTING THE SKIN. This is rather a rare form. This patient was in St. Mary's Hospital in 1903, under the care of Mr. Collier, who effected a cure by excising the mass and skin-grafting the bare area later.

swelling pointing over the lower part of the chest wall. On incision, a soft mass of readily bleeding granulation tissue is encountered, with a network of yellow granules in its midst. The appearance at first glance might suggest a fungating or sloughing sarcoma. Fever, anæmia, wasting, are noticeable features. Pain may or may not be present. Cough and expectoration may not develop till a late stage of the disease. The condition may spread subcutaneously over the thorax, and even across the axilla on to the arm; sometimes it invades the paravertebral groove posteriorly, and may cause abscesses which burrow through the erector spinæ. One side of the chest may be infected from the other by continuity of the disease across the front of the vertebral column.

The perforating type of thoracic actinomycosis is usually fatal within a year of the first symptoms.

4. **Miscellaneous.**—Other varieties of actinomycosis are comparatively rare. The skin (*Fig. 18*) is resistant to infection; but occasionally (see *Case 12*) the subcutaneous tissues may be directly inoculated. Infection of the ovary has been recorded, and the lachrymal passages have been attacked. The liver also has fairly frequently been attacked, but it is difficult to believe that this is more than a metastasis from some other focus in the alimentary tract; it certainly has little surgical importance.

DIAGNOSIS.

There are many indications that in this country actinomycotic infection is often overlooked or misdiagnosed. Therefore, it is well at the outset to

remember that actinomycosis may simulate many other disorders. It is often easy to say of a lesion that it is actinomyotic; it is very often, if not usually, difficult to say that it is not due to the ray fungus. The disease may occur in the most unlikely situations and under various guises, so that the only safe rule is always to consider it when dealing with any chronic lesion, whether apparently neoplastic or inflammatory.

Of the two main types of actinomycosis, the hard and the soft, the latter is the less characteristic, but should be the easier to diagnose with certainty at an earlier stage, for softening leads to the formation of an abscess containing the typical granules. A routine examination of the discharge from all chronic abscesses is therefore the best and only certain way of diagnosing the condition early. It is true that sometimes no true pus is obtained on incision, but only soft débris mixed with blood; nevertheless the material from such an incision should always be subjected to microscopical examination.

The indurative type is clinically more definite, but from a pathological standpoint more difficult to confirm, because the hardness may persist and no material be available for examination for months after the beginning of the illness. Even when soft material can at last be obtained, the granules of fungus may be exceedingly small, or absent, and only degenerated atypical mycelium be discovered in small quantities, on account of the secondary infection. Sometimes the secondary organisms entirely overshadow the streptothrix infection, and it is only at a later stage that the latter become predominant and typical. Occasionally the fungus may not be found at the first examination, but at a second or third attempt it may be demonstrated.

In cases which provide no discharge, it may be suggested that the removal of a small portion of tissue for microscopical examination would elucidate the diagnosis. Far from this being so, many sections of the indurated tissue in cases of undoubted actinomycosis may be cut and yet reveal no sign of the fungus under the microscope. It would appear that the formation of fibrous tissue in such cases is so great that the fungus is entirely crushed out of existence in some parts of the swelling. When it is found in the sections, it may be in the form of the typical ray fungus, with the club-shaped feebly-staining bodies at the periphery of the mass of mycelium. It is at least possible that the clubs represent some change which the marginal portion of the mass has undergone under the hostile influence of the tissue surrounding it. The agglutination reaction has not been utilized to any extent in the diagnosis of actinomycosis, but may occasionally be of some value.

Considering, therefore, the few opportunities of pathological investigation in the early stage of the indurated form, and the ambiguity or uncertainty of such examinations, an additional importance attaches to the clinical symptoms. If there is a very suggestive clinical picture, but the pathological examination be negative, the clinical diagnosis can be maintained until further and repeated examinations finally prove or disprove the diagnosis.

The diagnosis of actinomycosis needs to be made from the other forms of chronic inflammation and from the various malignant and simple neoplasms. In the soft type it more nearly resembles septic, syphilitic, or tuberculous inflammation; in the indurative form it more often resembles a neoplasm.

Septic Lesions.—Purely septic lesions are more acute and more painful; on incision, drainage, and other appropriate treatment, they generally subside; or if the patient's resistance is poor, may extend rapidly, with symptoms of general intoxication, in a way never simulated by actinomycosis. Glands are frequently enlarged and painful, and the skin is usually reddened at an early stage, or an abscess soon forms, or an extensive cellulitis with brawny œdema of the superficial parts. Although actinomycosis is occasionally ushered in with acute symptoms, such is not the general rule, and it is frequently the accompanying septic organisms which are responsible for the acute symptoms. Accurate diagnosis is only possible by a microscopical examination of any discharge or pus obtained on incision.

Tuberculous lesions.—These can be compared with those due to actinomycosis as follows :—

	TUBERCULOUS LESIONS	ACTINOMYCOTIC LESIONS
AGE	Occurs at any age from two years onward	Very rare under ten years of age. Occurs at any age after
COURSE ..	Chronic	The normal course would be accounted rather acute for tubercle
LESIONS ..	Often multiple	Rarely more than one focus
ULCERATION ..	Not uncommon	Uncommon
LYMPH-GLANDS	Commonly affected	Never affected
SITES	Skin, joints, bones, peritoneum are common sites	Skin, joints, bones and peritoneum rarely affected
PUS	Thin and yellow or caseous. No odour	Contains granules of fungus. Sometimes stinks
SCARS	Weak, thin, and not puckered	Often very puckered
PAIN	Usually absent	Often absent, but more likely to be present in stage of softening

Microscopical examination of the discharge will show the streptothrix in the one case, and may, but more often does not, reveal the bacillus of tuberculosis in the other; whilst sections of tissue may demonstrate giant-cell systems or clumps of the ray fungus respectively.

Syphilis.—The lesions of tertiary syphilis have to be distinguished from actinomycosis. A gumma is not painful in its development as are some of the more acute cases of the latter disease, and its progress is much more rapid. When softening occurs, a superficial gumma destroys a considerable amount of the overlying skin or mucous membrane, and forms an ulcer with a typical base which is unlike anything ever produced by actinomycosis. No granules are obtained, and the wash-leather sloughing area exposed is characteristic. Bones are more frequently affected by syphilis, and necrosis may follow. Other evidences of syphilis are often obtainable, and the Wassermann reaction may help. The value of the latter is chiefly of a negative nature, for a positive reaction does not exclude actinomycosis.

That form of tertiary syphilis which is accompanied by the formation of much dense fibrous tissue may present great difficulties until the course of the disease shows some determining factor. The differential diagnosis by observing the result of administering iodide of potassium is impossible, since both diseases are benefited thereby.

Neoplasms.—Some varieties of the hard form of actinomycosis can be mistaken for a fibroma or osteoma, sarcoma or carcinoma. The two former tumours are much slower in their formation, more circumscribed and distinct in outline, and do not soften like the lesions due to the ray fungus. A radio-gram will determine the presence of an osteoma.

The only places where carcinoma is likely to be mistaken for actinomycosis, or vice versa, are the tongue and the cæcum. In the tongue, a small hard nodule might be due to either disease. If the condition did not soon give definite indications of its nature by the discharge of pus with granules, the possibility of cancer would require that the nodule should be excised and microscoped.

The neoplasm which is more likely than any other to be confounded with actinomycosis is sarcoma. Both the soft round-celled and the hard spindle-celled forms may be simulated. Sometimes the lesions are so hard that the surgeon may think he is dealing with an osteosarcoma. But a sarcoma at the outset is generally more definite in outline, and may present irregularities on the surface. Until the stage of softening has arrived, actinomycosis generally presents a smooth surface without any irregularities suggesting unequal growth, whilst the border merges insensibly into the surrounding tissues. In the case of sarcoma near bone, an x-ray photograph may show new bone formation or other characteristic appearance. With sarcoma, lymphatic glands are quite commonly involved (contrary to the view sometimes taught), whilst this is not the case with actinomycosis. Secondary growths occurring in other parts of the body would point to sarcoma. Finally, a microscopical section would serve to distinguish the chronic inflammatory process from the neoplastic formation.

Some cases in which large masses of actinomycotic tissue form a soft vascular swelling on the surface, as for example in thoracic cases, may easily be taken for fungating sarcoma. The best way to distinguish is by very careful examination of the softened tissue.

DIAGNOSTIC FEATURES IN SPECIAL PARTS.

Region of the Lower Jaw and Face.—Here actinomycosis needs to be distinguished from the following :—

Simple Pyogenic Subcutaneous Abscess.—This is more acute in onset, more painful, usually subsides readily after draining, and the pus does not furnish the fungus granules.

Septic Periostritis and Alveolar Abscess.—This is much more painful and acute, is accompanied by more swelling of the gums, and soon leads to abscess.

Salivary Calculus.—Causes intermittent painful swelling in the sub-maxillary or parotid regions. Calculus may often be felt from the mouth. Softening does not follow.

Parotitis and Infection of the Submaxillary Gland.—Since infection with the streptothrix sometimes occurs along the ducts of Stenson and Wharton, it is clear that the initial symptoms may be exactly those of parotitis and submaxillaritis. In most cases of infection in these regions, however, the

salivary glands are not primarily involved. As a rule the swelling in actinomycosis is not confined to the area of the gland, and in a week or two the induration increases and the condition becomes more localized and definite. The internal openings of the ducts should be examined, and any escaping discharge microscoped.

Necrosis of the Jaw.—This condition, whether due to septic compound fracture, syphilis, acute periostitis, tubercle, or other cause, leads to a swelling something like that due to actinomycosis. The history helps much, and an x-ray plate more. It is noteworthy also that, with jaw necrosis, sinuses discharging pus are quite as likely to form on the inside of the mouth as exteriorly. This is not so common with streptothrix infection. Bare bone may be felt by the probe at the bottom of the sinus.

Cysts of the Lower Jaw.—These do not spontaneously suppurate and form sinuses, are more definite in outline, and can be distinguished by a radiogram. The rarefying form of actinomycosis may so expand the lower jaw as to form a large cystic space indistinguishable at first sight from a simple dental cyst. Both conditions are associated with carious teeth. A simple dental cyst is as commonly seen in connection with the upper jaw, whilst actinomycosis nearly always affects the lower jaw in the region of the molars. The only certain way to distinguish is by removing some of the fluid in the cyst and examining it carefully under the microscope.

A radiogram will detect an unerupted tooth in a dentigerous cyst.

Syphilitic Periostitis of the Mandible does not cause such dense or so extensive an induration, and may eventuate into a localized gumma or local necrosis of the jaw. In either case the distinction can be readily made by the history and clinical features, with the aid of a radiogram and a complement-fixation test for syphilis.

Tuberculosis of the Lower Jaw is very uncommon in the region of the angle. The process of the disease in the bone leads to the formation of small sequestra, which are extruded, or can be removed from time to time through the sinuses which form, both on the inner and outer aspect of the jaw. The pus which exudes from the sinuses does not contain any granules of the streptothrix. A history of tuberculosis in the same family may be obtainable. An x-ray photo will show the rarefaction and indistinctness of outline which is usually associated with tubercle in bone.

Inflammatory Phenomena associated with an Impacted Wisdom Tooth.—This may cause some difficulty in diagnosis. It is quite probable that the streptothrix sometimes gains access to the tissues through the abrasion caused by an erupting wisdom tooth, and at first there might be great difficulty in diagnosis. It is quite likely that the two conditions are often confused. As soon as softening has occurred, any doubt can be dispelled by examining the discharge.

Sarcoma.—It might be impossible to distinguish the early stage of a fibrosarcoma from a small nodule of actinomycosis. As a rule the sarcoma would stand out more prominently from the jaw and should have slightly more defined borders, whilst actinomycotic lesions cause a more diffuse swelling with indistinct border. A sarcoma may cause a symmetrical swelling on both aspects of the jaw; actinomycosis commonly affects only the outside. When softening occurs diagnosis is easy.

A myeloid sarcoma of the mandible should develop more slowly than actinomycosis; it would not cause infiltration of the cheek, and would be suspected when an x-ray photo was examined. Exploration might be necessary to distinguish it from that form of actinomycosis which expands the lower jaw and forms a large cyst.

Cæcal Region.—The form which follows an apparently ordinary attack of acute appendicitis is not likely to be diagnosed till some weeks have elapsed after the operation, unless the examination of the appendix showed the presence of the streptothrix. The persistent sinus will make the surgeon think of the possibility of the presence of a concretion, ligature, minute faecal fistula, or ill-drained loculus of pus, to account for the condition. When the induration supervenes, the diagnosis will be suspected, and by this time the fungus granules will easily be discoverable by scrapings taken from the sinus.

That variety of the disease which has an insidious and chronic onset first presents itself as a hard tumour in the right iliac fossa. The conditions which would have to be considered in differential diagnosis would be: cancer, or the indurated form of tubercle, of the cæcum, osteoma or sarcoma of the ilium, and chronic appendicitis with thickening due to other organisms than the streptothrix. Exploration would be necessary in any case, for it would be nearly always impossible to decide without visual examination of the mass.

Thorax.—It would be out of place here to discuss the differential diagnosis of thoracic actinomycosis from pulmonary tuberculosis and neoplasms of the mediastinum or lung, other than to lay stress upon the facts that the streptothrix generally attacks the base of the lung, and tends to infiltrate and perforate the chest wall at the level of attachment of the diaphragm.

From the strictly surgical point of view, the simulation of abdominal disease by the condition is important. The intercostal nerves may be irritated, and pain be referred to the right or left hypochondrium. If on the right side, such pain may easily lead to a diagnosis of gall-stones or duodenal ulcer; in one of the cases recorded below, abdominal exploration was undertaken under the impression that one or the other was present. The signs found at the base of the lung may be interpreted as a subphrenic abscess, but a radiogram should show whether the lesion was above or below the diaphragm. When the disease has penetrated the chest wall a fungating sarcoma has been diagnosed; this mistake can be avoided if some of the softened material be examined carefully under the microscope. Generally, however, the appearance of the soft material is absolutely characteristic; the meshwork of fairly large granules in the red granulation tissue being unlike any other condition.

TREATMENT.

In certain parts of the body and under certain conditions, actinomycosis tends to recover naturally. Treatment yields best results in the face and neck regions. Lung actinomycosis of the penetrating type cannot be controlled by any means at our disposal, whilst when the cæcal region is affected the prognosis is not very much better. If the lesion is in a region where the whole affected area can be removed, the prognosis is very good.

The methods of treatment at our disposal are as follows:—

(1) Constitutional measures; (2) Medicinal drugs, especially potassium

iodide and other iodine preparations; (3) Antiseptics, applied locally; (4) Vaccine therapy; (5) Surgical operations; (6) Radiotherapy—*x*-rays and radium.

Constitutional treatment should be conducted on lines similar to those for tubercle. Good feeding and fresh air are most important in helping the body to resist any chronic infection.

Medicines.—Of the drugs used in treatment, the preparations of iodine are by far the most important. Potassium iodide has been vaunted as a specific for the condition. Whilst such a claim is demonstrably incorrect, there is no doubt that rapid improvement, with softening, often takes place under its influence, especially in buccal cases. It has been asserted that the drug acts by causing absorption of granulation tissue; its beneficial action in the granulomata of tertiary syphilis lends support to that view. To be of much value, the drug must be given in large doses up to as much as ninety grains a day. Other preparations of iodine, such as iodipin, have also been used by some, with beneficial effect; but the writer has no personal experience of their effect. The intravenous injection of salvarsan has been tried (*vide Case 11*) without any particular beneficial effect. Iron preparations may be necessary for the marked anæmia which develops in chest and abdominal cases.

Antiseptics.—Not much value can be attached to the local application of antiseptics to any open lesions which may be present. It is reasonable to apply a solution of iodine to any sinuses, and in view of the preference of the organism for anaerobic growth conditions, hydrogen peroxide is to be recommended as an application to abscess cavities.

Vaccine therapy is a valuable method of treatment, but, equally with other methods, fails to make much impression on extensive thoracic and abdominal cases. Vaccines are needed both for the streptothrix infection and for the secondary infection which is so commonly present. In both instances it is better to use an autogenous vaccine; but a stock vaccine may be utilized until the more efficacious preparation is ready. The dose of the actinomycotic vaccine must be carefully regulated by the reaction which occurs in the patient. It is wise to begin with small doses (say half a million fragments), and work up to that dose which seems best for the particular patient. Doses of more than fifty million have been given. The interval of dosage also varies according to the patient's reaction under treatment; the common interval is from three to seven days. The other vaccines which may be required depend upon the organisms found by a careful bacteriological examination.

Surgical measures comprise incision, excision, and scraping. Incision is required to let out any accumulation of soft material or pus. Excision of the whole infected area is sometimes, but rarely, possible, and is clearly the best treatment where no important structures are involved and a speedy cure is desired. Scraping of sinuses may be desirable occasionally, but scraping is at the best an expedient, and is seldom necessary.

X-rays were used in the treatment of some of the cases recorded below, but did not have any marked beneficial effect. Possibly softening is hastened by their aid, but certainly not to any great extent.

Radium was applied to one of the thoracic cases, with marked immediate benefit. A dose of forty-seven milligrammes was inserted into the middle

of the infiltrated base of the lung after resection of a rib, and was left in for twenty-four hours. The diseased tissues sloughed in large masses, and the change in the lung was appreciable. Whether the disease has to any extent been stayed is of course impossible to say yet.

SUMMARY OF CONCLUSIONS.

Actinomycosis is a disease common in London and the vicinity, and probably also in other parts of this country.

The condition is frequently overlooked and wrongly diagnosed as septic or syphilitic infection, or as sarcoma.

Actinomycosis should always be considered in the diagnosis in the case of any newly-formed subacute or chronic swelling in the region of the mouth, face, neck, thorax, or right side of the abdomen.

Infection with the fungus nearly always occurs from the alimentary tract.

There are two clinical forms of the disease, the hard and the soft. The hard variety softens after two or more months.

Pus from every abscess should be examined as a routine practice. In any sub-acute or chronic lesion, the discharge needs to be repeatedly examined.

Peri-buccal infections comprise the majority of the cases. Here the organism enters most often through the mucous membrane of the alveolar margin near a carious or erupting tooth, or through the tooth socket into the jaw.

The fungus is taken in with the food, and lodges round the teeth. The features of the hard peri-buccal form are very characteristic, and can often be diagnosed long before pathological investigation can give much help.

Treatment by the administration of iodides, by vaccine therapy, and by surgical measures, promises the best results.

ILLUSTRATIVE CASES.

I append brief accounts of thirteen cases of actinomycosis which have been under my care. Only one (*Case 5*) was referred to me with a diagnosis already made. All the rest were met with in the ordinary routine of out-patient and in-patient work. In eleven of the cases cultures of the streptothrix were obtained agreeing in most of the essential characteristics. I have not included any cases of infection with forms of streptothrix which did not lead to the formation of granules of the fungus in the tissues, and cases of infection with streptothrix differing in any other essential from the usual form have been excluded. The cultures were made by Dr. L. Colebrook, whose researches on the subject are as yet unpublished.

It is unnecessary to add that for the purposes of generalization the writer has profited by many other cases under the care of his colleagues which he has had the privilege of seeing.

Case 1.—Actinomycosis behind angle of jaw. Infection of tonsil.

F. H., age 10. The patient came to hospital complaining of pain in his throat. He stated that he had tried to swallow some grass, but it stuck in his throat. The house physician incised the right tonsil, which was swollen. Within three or four days a swelling developed behind the right angle of the jaw, so he was referred to me

in the out-patient department. Within a month softening occurred, and an abscess was opened externally from which typical granules were obtained. Later the piece of grass was discharged from the sinus. A good recovery occurred and the boy continues well.

Case 2.—Submaxillary actinomycosis

F. C., age 18. The patient was sent up from Herne Bay to St. Mary's Hospital, in 1912, because of a swelling in the right submaxillary region which had been developing for some weeks; a molar tooth had been extracted previously to my seeing him. Examination showed a very hard, painless mass of tissue in the right submaxillary and submental regions. The edges of the swelling were not very definite, and the skin over it was normal in colour. Treatment was continued in the out-patient department for several weeks, but no improvement occurred, so he was sent into the hospital under the care of my colleague on November 4, 1912, with the diagnosis of actinomycosis. An incision was made, but no pus obtained, so the whole mass was excised. The submaxillary gland was found intact underneath the mass. Microscopic sections of the hard tissue showed a typical actinomycotic focus, the peripheral club-forms being very characteristic.

FIG. 19.—Case 6. PHOTOGRAPH SHOWING THE SMOOTH SWELLING OF THE CHEEK, most marked over the angle of the jaw.

Case 3.—Cervico-facial actinomycosis.

H. E., male, age 31. Occupation, carman; lives at Hayes, in Middlesex. Came to hospital in November, 1913, because of swelling of the right side of the face, and inability to open mouth properly. When first seen there was a diffuse, rather soft and painful swelling covering the parotid region and extending downward to the angle of the jaw and forward to the centre of the cheek. At first the diagnosis made was acute parotitis, but in a week or so the swelling became firmer, less diffuse, and localized to the region of the angle of the jaw. Softening occurred, and an abscess was lanced. Granules of actinomycotic fungus were obtained. The disease spread downwards along the line of the sternomastoid muscle, and subsided in the original area with the formation of puckered scars. Secondary infection with both cocci and bacilli was present.

Treatment by vaccine was successful. He is now perfectly well.

Case 4.—Peri-mandibular actinomycosis.

J. F., male, age 21, living in West London, by occupation a timekeeper on the Great Western Railway. When first I saw him, there was a firm smooth swelling extending upward and forward from the region of the right angle of the jaw. Marked trismus was present, severe pain in front of the ear, and some pain on pressing the swelling. The condition had been thought to be due to a wisdom tooth which was erupting. Extraction of the tooth had brought no relief. Actinomycosis was diagnosed, and when softening occurred in May, 1914, the material from the abscess was examined bacteriologically. Only *Bacillus fusiformis* was detected—no mycelium. The clinical condition was too definitely actinomycotic for one examination to suffice. Further investigations in June showed streptococci in the discharge, and a little atypical mycelium was found. At the end of July, three months after the clinical diagnosis was made with assurance, incision into a softened focus liberated material containing some definite actinomycotic granules. There were bacilli and cocci also present.

The disease was treated by potassium iodide and a vaccine of the fungus. Cure resulted in a few months. He is now quite well.

FIG. 20.—*Case 6. COLOURED SKETCH (from life) OF THE SOFTENED AREA.* An incision had recently been made and some gelatinous material wiped away. The central red area is therefore denuded of skin and shows the underlying granulation tissue. Granules of the fungus embedded in this tissue can be seen remarkably well. The surrounding livid area represents the soft actinomycotic focus covered by thinned skin. It must be remembered that it is rare for ulcers to occur naturally in the course of the disease.

(I wish to express my indebtedness to Mr. R. Clyne for the coloured illustrations (Figs. 13, 14 and 20), and for photographs (Figs. 19 and 22).

Case 5.—Mandibular and peri-mandibular actinomycosis.

G. E., male, age 19. Occupation, labourer; lives at Melton Mowbray. In the summer of 1912, the patient was treated at Leicester Infirmary for an abscess in the region of the left side of the lower jaw. A tooth was removed, and incisions made both from outside and within the mouth. The diagnosis at that time was parotid infection derived from a septic tooth. Later, Dr. Smyth, of Melton,

diagnosed actinomycosis, and gave potassium iodide internally. The swelling continued hard and discharged a little at intervals. There was hardly any pain.

In January, 1914, he was admitted to St. Mary's Hospital under the care of Sir A. E. Wright. At that time he was a well-nourished man; he complained of no pain, and had no general symptoms such as fever. There was a very large swelling centered about the ascending ramus of left lower jaw, very fixed to deep structures, but not to skin, and almost of bony hardness. It extended up to and beneath the zygoma. Scar near the angle of jaw with a little pus beneath. The pus contained granules of the streptothrix of actinomycosis as well as secondary organisms.

Treatment by x rays did little good, and potassium iodide in large doses caused little improvement, so I was consulted as to surgical intervention.

On April 9, 1914, a large part of the dense fibrous swelling was removed. It was intimately attached to the periosteum of the jaw. The outer lamella of the mandible was also chiselled away; the interior of the bone was traversed by many small sinuses filled with granulation tissue. A carious tooth and the tonsil on the

affected side were also removed. The tooth had a small carious cavity in the middle of its crown; some Gram-positive filaments suggestive of actinomycosis were found on it. One piece of filament suggestive of actinomycosis was also found in a tonsillar crypt. The mass removed was very dense and avascular, like cartilage.

Improvement followed operation, but the swelling recurred again. The disease is still active three years after its onset, though lately x rays have caused some improvement.

Case 6.—Peri-mandibular actinomycosis.

G. N., male, age 19. Occupation, a tailor. Came for advice to the Bolingbroke Hospital, December 19, 1914, on account of a swelling of the right side of the face which had been developing for six weeks. His doctor had made an incision

FIG. 21.—Case 6. RADIOGRAM OF THE JAW. This shows a condition of osteoperiostitis at the angle of the jaw. The carious stump of the second right lower molar tooth can be clearly seen. The affection of the bone is secondary to that of the soft tissues.

near the angle of the jaw, and a small sinus was still there. There was a large indurated swelling with centre near the angle of the jaw, with redness and superficial softening at the lower border of the mandible (*Figs. 19, 20, 21*). He could not open his mouth more than half an inch. Very slight or no pain on pressure. His teeth were good, except for a right lower molar, of which the decayed stump was still present, and a corresponding upper molar. Actinomycosis was diagnosed, and immediately confirmed by scraping the sinus and examining a stained film under the microscope. Treatment by potassium iodide is causing marked improvement.

Case 7.—Actinomycosis of the lower jaw with large central abscess.

Gladys K., age 16, consulted me at the Bolingbroke Hospital in January, 1915, for a swelling of the left side of the lower jaw (*Figs. 22, 23*). She stated that the swelling had been growing for the last twelve months, but that it had been getting much bigger just lately. Examination showed a swelling projecting from the outer aspect of the horizontal ramus of the mandible and extending from the position of the canine to the second lower molar tooth. The second bicuspid and first molar teeth in relation to the upper part of the swelling were carious, and only the stumps remained. The tumour was very hard and somewhat irregular on the surface. No fluctuation was felt anywhere, and the skin was free. At the first examination I diagnosed either a new growth (osteoma or sarcoma), or, in view of the carious teeth,

actinomycosis. The x-ray examination seemed to favour sarcoma. On February 13 the swelling was explored under an anæsthetic. On clearing the periosteum from the lower border of the mandible in the affected area, pus escaped from the interior of the cystic jaw through an opening caused by erosion of the bone, and the characteristic actinomycotic granules were at once seen. The carious stumps were removed, and it was found possible to pass a probe from the socket of the extracted teeth into the abscess cavity and out through the exploration opening. Immediate microscopic confirmation of the nature of the granules was obtained.

This case seems to prove clearly the relationship of carious teeth to jaw infection. The marked expansion and rarefaction of the interior of the bone left so thin an outer layer, that egg-shell crackling was noticed on pressing on the jaw while operating.

Case 8.—Ileocaecal case. Acute type.

D. R., female, age 16, was admitted to St. Mary's Hospital, November, 1912, with symptoms pointing to acute appendicitis. Operation revealed a perforated appendix with local suppuration. The appendix was removed, and drainage instituted. Convalescence was uneventful save that the sinus persisted. In January, 1913, the sinus still caused trouble and was indurated, and a

FIG. 23.—Case 7. X-RAY PHOTOGRAPH OF THE LOWER JAW, showing a large cystic expansion of the left horizontal ramus, caused by actinomycosis. The second bicuspid and first molar teeth were carious, and the stumps which remained led right into the large abscess cavity. Egg-shell crackling was obtained on firm pressure. The swelling was all on the outside of the jaw, the buccal aspect felt normal on palpation. The arrow points to carious stumps.

the right thigh. The temperature persisted for a month, and the patient became weaker and kept her right thigh flexed.

When admitted to hospital, December 20, 1911, her temperature was 101°.

FIG. 22.—Case 7. PHOTOGRAPH SHOWING THE SWELLING CAUSED BY THE CYSTIC EXPANSION OF THE LEFT HORIZONTAL RAMUS.

firm swelling was felt in the iliac fossa, so the track was scraped under an anæsthetic, and a search for a local abscess made. The scrapings looked like and proved to be actinomycotic matter. She was transferred to the care of Sir A. E. Wright and treated by vaccines. Counter-openings in the loin were necessary later, but the patient improved greatly, and now, after two years' treatment, has but a small sinus left. At one time this patient was seriously anæmic, but she has now recovered her strength.

Case 9.—Ileocaecal case. Chronic type.

Mrs. N., age 45, was sent to hospital from Hendon on December 19, 1911, because of severe pain in the right thigh. Her doctor stated she had ailed since October 12, when she had a febrile attack with muscular pains and headache. The fever subsided and she got about her work again; but on November 20, when she again consulted her doctor, the temperature was 101°, and she complained of constant aching pain in

Complexion sallow. Complained of pain in front of right thigh just above knee. Hip was flexed 30° or 40°, and could not be straightened without producing lordosis. Other movements at hip, except those that would stretch psoas, normal.

No abdominal pain. Definite lump felt in abdomen above Poupart's ligament in the iliac fossa; no pain or tenderness on pressure. Pelvis normal. No urinary troubles. Chronic appendicitis was diagnosed.

December 28, 1911. Operation revealed a chronic abscess with inspissated material, behind and internal to cæcum (*vide Fig. 24*). Base of appendix normal, but it led into abscess cavity situated behind the mesentery, which was common to ileum and cæcum. The stump of the appendix was removed and the abscess cavity drained. The walls of abscess were very firm. Psoas was infiltrated with cartilage-like induration.

January 20, 1912. Sinus track indurated. Temperature still elevated. Opsonic index to tubercle 1.38.

January 31, 1912. Sinus scraped. Actinomycotic filaments found in scrapings.

The patient was then transferred to the care of Sir A. E. Wright. She remained in the hospital many months and was treated by vaccines. Her temperature was very irregular, and secondary infection was ascertained. The disease extended upwards, outwards, and downwards, but the peritoneum was not invaded. The colon was pushed forwards by the retroperitoneal swelling. The general condition gradually became worse, and death ultimately took place in July, 1912, from septic bronchopneumonia. On several occasions an attempt was made to find the organism in the blood, but without success. The patient's serum had a high agglutinating reaction to the infecting streptothrix.

FIG. 24.—Case 9. DIAGRAM SHOWING POSITION OF RETROCÆCAL ACTINOMYCOTIC ABSCESS (shaded area).

At the autopsy, actinomycotic infiltration was found to extend behind the peritoneum up as far as the diaphragm and down into the pelvis. The extent of this infiltration was remarkable, and was described in the post-mortem record as follows: "The retroperitoneal tissues of the posterior abdominal wall and the posterior and lateral walls of the pelvis were necrotic and infiltrated with

thick pus. The condition extended upwards in and around the psoas muscles of both sides as high as the upper poles of the kidneys, while on the left side it spread over the front of the hip-joint into Scarpa's triangle and the inner side of the thigh."

Case 10.—Thoracic actinomycosis.

A. W., female, age 42. No other illness. Two brothers and a sister were said to have died of phthisis; one brother now in Infirmary. Had worked amongst straw in unpacking goods for her employer. Husband was a coachman.

The patient was admitted to the medical wards at St. Mary's Hospital in September, 1911, for pleuropneumonia. On October 29 she was transferred to the surgical wards for left-sided empyema. This was opened and drained by resection of part of the 7th rib.

Bacteriological examination of the pus revealed only pneumococci. After three weeks the patient was discharged well except that the sinus had not healed up. For five months patient carried out her ordinary duties in spite of the slight inconvenience of the sinus.

In March, 1913, a swelling developed below and external to the left breast. Within three weeks this softened and burst. On April 12, exploration under an anæsthetic showed several intercostal spaces to be infiltrated with granulation tissue which bled readily and contained many yellow specks, which on microscopic examination proved to be the mycelium of actinomycosis. Apparently there was no connection with the empyema sinus.

On April 16, patient was transferred to the care of Sir A. E. Wright. At the time of transference the notes state that she was thin and sallow and had an "earthy

"cachexia." Slight pyorrhœa, carious lower-teeth, irregular temperature, furred tongue, and dry hacking cough were noted. The lower part of the left chest was dull on percussion, and air entry was diminished. Several other organisms were found in addition to the streptothrix of actinomycosis.

Treatment by vaccines and potassium iodide was tried, and some improvement occurred at first. In October, 1913, further lesions developed in the left axilla, and in the upper part of the left breast and chest wall. Severe pain felt down arm. Temperature still very irregular, from 98° to 102°.

November, 1913. Actinomycotic streptothrix found in sputum. December, *x* rays tried (diffused through aluminium sheet). January, 1914. Vaccines stopped. Lesion spread posteriorly. February, vaccines restarted. Gradually became worse. Pulse varied from 120 to 140. Temperature from 98° to 102°. Death occurred on May 31.

At the autopsy on June 2, both lungs were found to be diseased. The lower part of the left lung was solid with actinomycotic disease, and this lung was totally adherent to the chest wall. There was consolidation of the right upper lobe, with cavity formation, and many small abscesses which proved to be actinomycotic. There was a connecting track of diseased tissue between the two sides, which had eroded the dorsal vertebræ. The only other focus of actinomycosis was a small area under the capsule of the left kidney. Marked amyloid disease was present in spleen and intestine—less marked in liver.

Case 11.—Thoracic actinomycosis.

H. B., male, age 29. Occupation in a woollen warehouse in London.

First sign of illness in November, 1913, when severe pain developed in the right hypochondrium and behind right shoulder. The pain persisted till I first saw him on December 1, when I made a provisional diagnosis of gall-stones. At the time there was tenderness and some rigidity in the right hypochondrium. No jaundice, vomiting, hæmatemesis, or melæna. Leucocytes, 11,500 per cubic millimetre. Pain in right shoulder subsided, but persisted in hypochondrium. He was feverish. Examination of chest showed dullness and impaired air-entry at right base, and *x* rays showed an abnormal area below right lung base. Exploration of pleura by needle did not reveal any fluid or pus. A physician who saw the case in consultation with me thought possibly a subphrenic abscess was present.

December 12. Exploratory abdominal section. Liver reached down to umbilicus. Gall-bladder distended. No gall-stones. Cholecystostomy performed. After operation, the pain in the back of the right chest still persisted. It was a constant aching or boring pain.

January 19, 1914. A large fluctuating swelling detected in the right loin and over the lower right ribs posteriorly. Patient about this time coughed up a lot of thick sputum which was not examined.

January 23. Large abscess opened and drained. Foul-smelling green pus came away. Thicker material near the ribs communicated with the interior of

FIG. 25.—Case 12. PHOTOGRAPH OF THE FRONT OF THE CHEST, showing the fungating growth of actinomycotic material which had perforated the chest wall. Radium was inserted into the midst of the infiltrated lung through the upper opening.

thorax through 11th intercostal space; actinomycotic granules were found in the pus. After operation patient spat up a little sputum and blood containing granules.

Patient transferred to the care of Sir A. E. Wright. The condition became gradually more extensive, and in spite of inoculation and other methods of treatment, death occurred in October, 1914. The infection spread upwards in the para-vertebral groove, and an abscess developed on the right side of the vertebral column. An autopsy was not obtained.

Case 12.—Thoracic actinomycosis.

B. K., a girl, age 13, living in North-west London, had right-sided pleurisy in May, 1914. This attack apparently passed off. During the second week of July she felt pain in the lower front of the right side of the chest; a week later a cough developed, but there was no sputum. On July 29 a swelling was for the first time noticed over the lower part of the right chest in front. Patient was admitted to hospital August 1, 1914. When admitted did not seem very ill. Her temperature reached 100° each evening. There was a swelling extending from the right margin of the sternum to 1½ inches external to the right vertical nipple line, and reaching

from the third to the seventh costal cartilage; it was dull on percussion and tender to the touch. A systolic murmur was heard at the level of the fifth costal cartilage near the margin of the sternum. Exploration of the swelling by a needle only withdrew blood. There was a leucocyte count of 20,000.

On August 28, 1914, the case was transferred to my charge. Incision of the swelling under an anæsthetic showed it to be composed of soft friable vascular tissue somewhat resembling a soft sarcoma. A little of this material was microscopied, and reported to contain some cells suggestive of round-celled sarcoma. For some weeks after this, the temperature persisted and the general condition became worse, so on October 1 a more extensive operation was done and a large mass of the

FIG. 26.—*Case 12.* RADIOGRAM OF THE CHEST, showing infiltration of the whole lower part of the right lung and adjacent mediastinum. No treatment by radium had yet been undertaken.

diseased tissue removed. At this time the appearance was such that I felt sure the condition was actinomycotic, and this surmise was confirmed by bacteriological examination. On October 16 she was transferred to the care of Sir Almroth Wright. She has been treated by vaccines with some, but not marked, benefit, and lately the insertion of radium into the midst of the diseased lung has been followed by some improvement. The first application of radium was followed by considerable sloughing of the infiltrated part of the lung. The patient is still under treatment. The appearance of the chest before the application of 47 mgrams of radium is seen in the accompanying radiogram (*Fig. 26*).

Case 13.—Actinomycosis of hand.

T. B., male, age 27. Was sent to hospital by his doctor because of an indolent inflammation of the right hand. It appeared that three months previously, in a fight with another man, he had knocked out some of his opponent's front teeth with a strong right-handed blow. Two days later acute inflammation set in, and extended

up the arm ; but soon the acute symptoms subsided, and the process became more localized and chronic. Several incisions had been made to let out pus, but the condition still persisted.

When first I saw him in March, 1914, there were several healed scars on the dorsal aspect of the first and second intermetacarpal spaces of the right hand. The skin was unhealthy-looking, and the subcutaneous tissues were the seat of what appeared to be an ordinary subacute septic infection. A discharging sinus was present. An incision was made, and some of the material obtained sent in the usual way for microscopical examination. Actinomycotic granules and mycelium were discovered. Patient was referred for treatment to the department for therapeutic immunization, and was given appropriate vaccine treatment. Within a month the condition was properly healed up. When last seen, February 1, 1915, his hand had remained perfectly well, and the only traces of the old trouble were the healthy white scars of incisions and a slight limitation of movement at the metacarpophalangeal joint of the first finger.