Clinical Remarks

ON

PULMONARY TUBERCULOSIS IN INFANCY AND CHILDHOOD.

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INCIDENCE.

THE early diagnosis of intrathoracic tuberculosis in infants and young children is often a matter of extreme difficulty. Too often the condition is hardly suspected until general millary infection occurs, or until widespread changes in the lung texture render it only too obvious. The reasons for this difficulty are not far to seek. The non-appearance of sputum, the number and variety of affections of the respiratory apparatus to which children, especially those brought up in the unhealthy conditions incidental to town life, are liable, and the greater proportionate size to which the lesions have to attain in order to render their presence demonstrable by physical examination are all factors. Again, the fact that the manifestations of the disease are often ushered in or accelerated by some acute infectious disorder, such as measles or whooping-cough, is one to bear in mind, since the sequence may divert attention from the grave nature of the respiratory condition and the ill-health of the child may be attributed erroneously to the debilitating after-effects of the primary disease. On the other hand, many cases are labelled as pulmonary tuberculosis on very insufficient grounds, such as the association of anaemia and malaise with a chronic cough and night sweats. Again, certain cases showing suggestive signs may clear up completely, so that it is important in doubtful cases to make more than one examination of the chest or to confirm the diagnosis by some of the newer bacteriological methods, which, however, are not always available and are not invariably desirable.

It is difficult to form an accurate estimate of the incidence of pulmonary tuberculosis in infancy and childhood, and the most widely divergent statements are current in this regard. The chief reason for this diversity of opinion is the confusion of nomenclature which exists, since by some authors the term "pulmonary tuberculosis" is taken to include tuberculosis of the tracheo-bronchial lymphatic glands, which is admittedly very common, while by others it is restricted to those cases of destructive disease of the lung similar to the types of pulmonary tuberculosis in the adult, which are by universal consent comparatively rare. For this reason statistical observations, unless carefully compiled and analysed, serve but to increase the confusion. Recently, however, the methodical examination of groups of school children in this and other countries has afforded some interesting figures. Grancher and his assistants, working among the school children of certain districts of Paris, found that 141 out of 896 examined showed evidences of glandular or pulmonary tuberculosis—that is, about 15 per cent.; and in a subsequent investigation of 4,226 children they obtained identical results, but they certainly included as cases of bronchial gland tuberculosis many which were of very doubtful nature. Dr. J. E. Squire and Dr. Annie Gowdey, after careful examination of 1,670 children in certain of the schools of the London County Council, found only 8 with signs of pulmonary tuberculosis—that is, 0.47 per cent., or if 14 other cases with doubtful signs be added, the percentage becomes 1.3 per cent. These statistics agree fairly closely with those of Leubuscher, who found about 2 cases in 1,200 to 1,400 school children in Germany. Statistics derived from *post-mortem* examinations, on the other hand, although they show the incidence of tuberculosis in children dying in certain general hospitals, fail to afford information as to the general incidence of the condition among the living, and cannot strictly be taken even as giving the general mortality, since they are often derived from hospitals for infectious diseases, or from other special sources. They serve, however, to indicate the distribution of tuberculous

lesions in the body. Barthez and Rillet some fifty years ago found such lesions in 33 per cent. of the cases examined by them in certain of the children's hospitals of Paris. J Comby has recently published statistics from the same hospitals showing 38.5 per cent. Müller in Munich found 43 per cent. among 500 *post-mortem* examinations; Baginsky in Berlin found only 18 per cent., whilst Hamburger and Sluka, in 401 *post-mortem* examinations most carefully carried out in Vienna, found tuberculous lesions in 160 cases—that is, in 40 per cent. These figures, however, are for tuberculous lesions in general; the incidence on the lungs and bronchial glands has now to be considered. Hamburger and Sluka found the lungs affected in 50 per cent., the bronchial glands in 98 per cent. These figures differ from those of Holt, who found the lungs involved in 99 per cent., the bronchial glands in 96, but both sets show that pulmonary lesions are common in fatal cases. It is probable, however, that in a considerable proportion of these the pulmonary lesions were terminal in character, and that the cases could not be regarded as tuberculosis of the lungs in the ordinary sense.

In order to form an estimate of the frequency of pulmonary tuberculosis in regard to other causes of cough I have analysed the records of 337 cases of children under the age of 15, the majority being between 7 and 14, brought to my out-patient department at the Brompton Hospital for cough, expectoration, and wasting, and found only 45 showing definite signs suggestive of tuberculous disease of the lungs, in only a small number of which was the diagnosis confirmed by examination of the sputum.

ETIOLOGY.

In regard to the etiology there are two chief points for consideration, both of which are the subject of some controversy at the present time—namely, first, the manner in which the child becomes infected with the tubercle bacillus, and secondly, the part played by various predisposing causes in determining the infection and its site.

In regard to the manner of infection there are five possibilities for discussion—namely, (1) transmission from the mother to the fetus *in utero*: congenital or hereditary tuberculosis; (2) inoculation of wounds: inoculation tuberculosis; (3) inhalation of tubercle bacilli in dust: aerogenous or inhalation tuberculosis; (4) by swallowing bacilli in food, especially milk: ingestion or enterogenous tuberculosis; (5) infection through the ear, Eustachian tube, or tonsil. The first two of these may be summarily dismissed. Congenital tuberculosis has been conclusively proved to occur by the discovery of tubercle bacilli in the organs of the fetus and in the placenta, and also by experiment in animals. Inoculation has also been proved in infants, as the oft-quoted case of the infection of the circumcision wound by a tuberculous rabbi shows; but both these means of infection are so rare as to be curiosities. Infection through the ear probably only occurs in a limited number of cases.

The problem for discussion is therefore narrowed down to the establishment of the relative frequency of aerogenous and enterogenous infection. Opinions on this question have shown remarkable changes in recent years. For a long time infection in early life was regarded as mainly enterogenous and due to milk. Subsequently there was a tendency to regard infection as chiefly aerogenous, and the preponderance of old lesions in the bronchial glands pointed out by many observers—notably by Dr. Still in this country—apparently gave very strong support to this view. The matter was focussed to burning point by Koch's startling pronouncement in 1901 as to the duality of the human and bovine diseases. Since that time this question has been studied in many countries and by many observers, but even yet there is no unanimity of opinion. One of the most valuable contributions to the subject has been the work of the Royal Commission on Tuberculosis, of which certain reports have recently been published. The Commission finds that from the lesions of tuberculous disease in man two types of bacilli can be obtained—one identical in cultural and pathogenic properties with the bovine bacillus, the other, with slightly different cultural characters and markedly different pathogenic properties for bovines and guinea-pigs, constituting the human type. The possibility of infection from bovine sources is therefore established, and once more the relative frequency of

enterogenous and aërogenous infection becomes a question for discussion. It is impossible here to do more than refer to the nature of the evidence brought forward, and in illustration the interesting feeding experiments of Calmette, Guérin, and Delarue may be briefly alluded to. They fed young bovines on food to which bovine bacilli had been added, and confirmed the view that these bacilli can be absorbed from the intestine without producing a local lesion, and further demonstrated that they may remain in the mesenteric glands without producing tuberculous changes, but that sooner or later lesions appear in the tracheo-bronchial and retropharyngeal glands with or without pulmonary implication. These results, if they are reliable—and they have been confirmed by Vallée and other observers—show that the presence of the most advanced lesions in these glands in any particular case cannot be taken as necessarily proving an aërogenous infection. The supporters of the aërogenous manner of infection point to the statistics of the age incidence of tuberculosis in the early periods of life in support of their contention. Among the most important of these are some statistics of Comby, who found the mortality from tuberculosis to be slight in the first six months of life, increasing slightly up to the age of 1 year, then greatly increasing in the second year, and thereafter increasing more gradually till the tenth year. In other words, the mortality increases steadily through infancy after the first few months, during which the infant's environment is restricted, and increases more or less regularly with age. Comby regards these figures as supporting a direct infection from association with other sufferers rather than an infection by milk. It is further pointed out that in countries, like Japan, where cow's milk is little used as an article of diet tuberculosis in children is as common as in other countries. On the whole, the question cannot be regarded as settled, but it is wise to bear in mind both possibilities in regard to infection in infants and young children, and to take preventive measures accordingly.

Similarly, the part played by predisposing causes is difficult to appraise accurately, but is a matter of importance in regard to prophylaxis. The condition of infancy is itself undoubtedly one of high susceptibility—the resisting power is low, and therefore very short exposure to infection is sufficient to produce the disease. Wassermann has recorded a case where a fatal tuberculosis was induced in a suckling after eight days' residence in the same house with a tuberculous person, while Reich mentions the case of a maternity nurse in a village who suffered from active tuberculosis, and was in the habit of applying her mouth to that of the newborn infant to suck away mucus or blow in air, with the result that ten such infants died of tuberculous meningitis. In regard to the existence of an inherited predisposition to the disease, there is still some difference of opinion. Squire and Maxon-King have both brought forward statistics which they regard as indicating that the children of tuberculous parents show, if anything, a slightly lessened susceptibility—a conclusion which is certainly contrary to the general consensus of opinion. The part played by defective hygienic and domestic conditions in the genesis of the disease is illustrated by Mercler's observations. He found that only 3 per cent. of the children of consumptive parents who were sent to the country died, while no less than 50 per cent. of their brothers and sisters who remained at home succumbed. The importance of cleanliness of the child and of his surroundings is further shown by the work of Preisich and Schütz, who found tubercle bacilli in the dirt under the nails in 14 per cent. of 68 children between the ages of 6 months and 2 years. Measles and whooping-cough are frequent antecedents, though whether they act by rendering the swollen bronchial glands more vulnerable, or by leading to a spread of a quiescent or localized lesion, is difficult to determine. From the rapidity of advance in some cases, the latter is the more probable. The frequency of a history of injury or slight shock before the onset of general miliary infection, of local injury before joint and bone lesions, suggests that the general or local protective mechanism may be depressed by such agencies.

PATHOLOGICAL ANATOMY.

Although the histological changes induced by the tubercle bacillus in the tissues of infants and young

children are in all essentials identical with those produced in adults, yet there are certain important differences in their distribution, course, and consequences which it is necessary to bear in mind, since they serve to explain the peculiar clinical features of the disease in these periods of life. The tubercles, which are of typical giant celled character, develop rapidly, and show a marked tendency to coalesce. In regard to secondary changes, caseation is the almost invariable rule, while calcification and fibrosis are extremely rare, at any rate before the age of 4 years. A second peculiarity is the special proneness of lymphatic structures to be implicated primarily or early. The third and most striking characteristic is the tendency towards generalization from blood infection, leading to miliary deposits in the organs, especially in the meninges. This occurred in 114 out of 238 tuberculous children observed by Dr. Still—that is, in 48.3 per cent. of the cases; while Hamburger and Sluka found that this was the actual cause of death in 80 out of 110 cases—that is, in 73 per cent. The most characteristic *post-mortem* lesions at these periods of life are large masses of conglomerate caseated tubercles in the oldest sites of the disease, and miliary or early caseous lesions elsewhere. There are usually but few changes in the tissues around the tubercles other than simple inflammatory non-reparative processes—for example, simple consolidation of lobular distribution around the tuberculous deposits in the lungs. The special characteristics of the disease in infancy and early childhood may be summarized briefly in the statement that the lymphatic system appears to be the most important means of protection, and that when this barrier proves ineffective through caseation and the subsequent changes, there is a great tendency to rapid unchecked growth owing to deficient local and general protective reactions.

In regard to the sites and distribution of the lesions in intrathoracic tuberculosis, it is necessary to insist once more on the great frequency with which the bronchial or tracheo-bronchial glands are affected, either primarily or as a process secondary to pulmonary infection; and, further, to point out that the lesions in the lungs do not, as a rule, follow the well-known laws of spread from apex downwards. The lesions even in later childhood, when they tend to approximate more towards those in adults, are usually diffuse, and very often are most marked in the parts of the lung adjacent to the root.

For purposes of description it is best to consider the cases on the basis of an anatomico-clinical classification in four types:—(a) Tuberculosis of the tracheo-bronchial glands; (b) acute miliary tuberculosis; (c) acute caseous tuberculosis; (d) chronic or fibro-caseous tuberculosis. A type corresponding to the fibroid tuberculosis of adults can hardly be said to exist.

In tuberculosis of the tracheo-bronchial glands it is usual to find these glands markedly enlarged and more or less completely occupied by soft yellow cheesy material, presenting a very striking and characteristic appearance. Sometimes miliary tubercles may also be seen in some of the glands. The glands on the right side are most frequently involved if the affection is unilateral, but usually the whole group is implicated, and even the glands on the course of the intrapulmonary bronchi may be extensively affected, forming yellow spherical masses sometimes as large as small cherries. In Hamburger and Sluka's cases the glands on the right side were involved in 64, those on the left in 14, while in 77 both sides were affected, those on the right side being invariably the more marked. In rare cases these glands may exfoliate into the trachea, or perforation may occur into a bronchus or into the oesophagus.

Miliary tuberculosis of the lungs may be part of a general miliary affection, produced by breaking down of a caseous bronchial gland into the blood stream, or by the same process occurring in a tuberculous focus in a blood vessel—the so-called "intimal tubercle" of German authors. On the other hand, the miliary outbreak may in some cases be confined to the lungs. In either case the lungs are found to be thickly studded with small grey translucent miliary tubercles, often in enormous numbers. They can be seen under the pleura, and on section they project slightly. The surrounding lung tissue may be practically normal in appearance or present a condition of partial or complete consolidation. The oldest lesion, and the one to which the miliary outbreak is

due, is usually found to be caseous and in process of softening.

Caseous tuberculosis of the lungs, as in adults, occurs in two forms—one lobular, the other lobar, or pseudo-lobar, in distribution. In the lobular form the appearances are somewhat similar to those in the acute miliary, of which indeed they represent a later stage. The lungs are riddled with small yellow conglomerations of caseated tubercles, and the pulmonary tissue around is generally in a condition of consolidation often undergoing caseation. In the oldest lesions, usually those about the root of the lung, some indications of softening may be apparent, and small cavities may appear, but these rarely attain any size. The lobar form, which Dr. Goodhart describes under the name of cheesy consolidation, is much less common. The whole of one lobe or practically the whole of, one lung may be converted into a solid cheesy mass in which little or no lung tissue may be recognizable. A pseudo-lobar form may arise from coalescence of large areas of bronchopneumonic distribution like those in the first form.

Chronic fibro-caseous tuberculosis of the lung tends more towards the chronic form of adults, and does not require detailed description. It is extremely rare under the age of 4 years, but is the usual form in later childhood.

In connexion with morbid anatomy, reference may be made to certain special features. Cavities are usually stated to be rare in children; but, although they are difficult to recognize clinically, they are not infrequent. Geipel found 7 cavities in 20 cases in infants; Hamburger and Sluka found 18 cavities in their 110 cases. When they occur, they are usually small and of recent origin. They may contain a sequestrum of broken-down lung tissue. Pleurisy is common, and may lead to interlobular and parietal adhesions. Occasionally a serous or purulent effusion may occur. Pneumothorax is rare, but according to Cruchet of Bordeaux it is less uncommon under the age of 4 years than between the ages of 4 and 15. The cases in which it occurs are most often of the caseous bronchopneumonic type, and the most frequent site is at the base of the left lung. It is invariably a pyopneumothorax. In regard to the associated lesions in other organs in cases of intrathoracic tuberculosis intestinal ulceration is common, which is not surprising owing to the swallowing of the sputum. This ulceration is usually associated with some localized peritonitis and with infection of the mesenteric glands. Laryngeal tuberculosis may occur in children, and instances are on record in quite young infants. In generalized miliary tuberculosis miliary tubercles may be found very widely distributed through the various organs, and those in the choroid may have a diagnostic value if observed during life.

SYMPTOMS AND PHYSICAL SIGNS.

(a) *Tuberculosis of the Tracheo-bronchial Glands (Bronchial Phthisis).*—Owing to the deep situation of these glands, it is a matter of great difficulty to establish the diagnosis at a time when they are alone affected. Many, if not all, of the signs described by various authors are of very equivocal significance, and at present in many cases it is impossible to be certain of the diagnosis. An apparently causeless but progressive condition of ill health associated with a distressing paroxysmal cough, like that of whooping-cough in character, and worse at night, should excite suspicion. The children may or may not present the so-called tuberculous appearance to be subsequently described, but they become anaemic, fretful, and depressed, and night sweats are common. With regard to physical signs, on inspection it is said that puffiness of the face may occur as in pertussis, and there may be some dilatation of the veins over the upper part of the chest, and a marked growth of downy hairs on the back, but neither of these signs is in my experience of any value. On palpation in the episternal notch, some glandular enlargement may be felt in rare cases. On percussion, there may be dullness over the manubrium or to one side of it, or at the back beside the upper dorsal spine, especially on the right side. On auscultation, a permanent alteration of inspiration at one apex is regarded by Grancher as sufficient to indicate this condition. This author described three stages in this alteration, but it is probable that he attached too great importance to the auscultation of the breath sounds. The signs described are weakening of inspiration and later bronchial breathing

with bronchophony. It is stated by D'Espine that in the normal child bronchophony ceases at the level of the spine of the seventh cervical vertebra, while in these cases it may be heard down to the level of the fourth or fifth dorsal spine. This I have been unable to confirm. Occasionally there may be weak breathing over the whole of one lobe, but even in these cases it is well to remember the functional irregularity of the diaphragmatic movements of children, which can be readily observed with the *x* rays, and to examine the chest on several occasions to see if the alteration is a permanent one. A further auscultatory sign is that described by Dr. Eustace Smith, namely, a systolic murmur heard over the manubrium sterni when the head is held far backwards. In my experience it is not a sign of any diagnostic value. Radiographic examination of the chest may sometimes afford confirmatory evidence of disease of these glands, but is not to be relied upon unless the enlargement is marked. The coexistence of several of these signs, especially if one of them be dullness in the interscapular region, with a positive tuberculin reaction, renders the diagnosis highly probable.

(b) *Miliary Tuberculosis of the Lungs.*—In considering miliary tuberculosis in the young it is important to remember that the actual symptoms as ordinarily recognized are those of the terminal stages of the process, the actual deposit of the primary focus having occurred at some period anterior in time, probably in some cases a considerable time previously. There is thus a latent period in these cases when there are few if any symptoms, or at most some indefinite condition of malaise or ill-health. The rapid progress and almost inevitably fatal character of the later manifestations render this condition one of the most tragic diseases of early life. It is perhaps not too much to hope that in the near future the means of diagnosis and treatment which the study of bacteriology promises to afford will enable treatment to be started during this period of latency, so as to increase the powers of resistance, whether by vaccines or other agencies, and thus rob of its terrors one of the most hopeless of diseases.

In regard to the clinical characteristics of this condition they differ according to whether the case is one of generalized infection or one with pulmonary dissemination only, and in the former instance they vary with the age of the child and the preponderating localization of the tubercles. It is possible to recognize at least four clinical types, although they tend to merge one into the other, and are by no means sharply defined. The first of these, which may be referred to as the *marasmic type*, occurs almost without exception in infants. The symptoms are chiefly progressive emaciation, diarrhoea, and exhaustion. Convulsion may occur towards the end. There may be little or no fever, and pulmonary symptoms may be entirely wanting. The second type tends to simulate typhoid fever, and may be called the *acute febrile type*. There is marked fever, of continuous or remittent character, with rapid prostration and emaciation. The spleen is early enlarged, and there may be diarrhoea. Cyanosis and dyspnoea out of all proportion to the pulmonary physical signs are suggestive features. An afebrile period may occur, and the condition may close with meningeal symptoms. A third and characteristic form of miliary tuberculosis is the *meningeal type*—in which the symptoms are those of tuberculous meningitis. It is outside the scope of the present paper to describe the symptoms of this condition, but it is important to remember that any case of tuberculosis may end in this manner. It is also noteworthy that in any general infection with a meningeal implication, the meningeal symptoms usually dominate the clinical picture and mask the signs due to affection of other organs or systems. The fourth type of miliary tuberculosis is the *pulmonary*, and in this form the course is, as a rule, longer than in the others except the marasmic. The symptoms are usually those of a disseminated bronchopneumonia from which, indeed, it may be difficult to distinguish it. The onset is frequently acute with anorexia, malaise, fever, and even convulsion, or, on the other hand, it may be more insidious, with progressive languor, anorexia, and wasting. In either case, symptoms referable to the respiratory system soon supervene, notably increasing dyspnoea, tending towards an expiratory type with short inspiration succeeded by audible puffing expirations, the pause in some cases

occurring after inspiration. Objective signs of dyspnoea soon become obtrusive, increasing rapidity of respiration to 60 or 80 per minute, dilating nostrils with each inspiration or shortly preceding it, and a deepening naso-labial line. Cyanosis of some degree soon develops. Cough, frequent and rather dry in character, is often present, but is not invariably a marked feature, and may cease long before death, and in some cases may be almost absent throughout. Expectoration is absent or is swallowed. Death occurs from exhaustion or in a convulsion, or with the occurrence of meningeal symptoms. The physical signs may simply suggest the existence of a bronchopneumonia, and, as a rule, are not characteristic. There may be intercostal recession, the abdomen becoming prominent during each inspiration. The face is usually pale, the lips and ears cyanosed, the finger tips cold and blue. As a rule, no dullness may be obtained on percussion, but sometimes patches of impaired resonance may be found. On auscultation, areas of broncho-vesicular breathing, or of actual tubular breathing, may be heard with increased voice sounds and pectoriloquy. On the other hand, areas of harsh breathing alternating with others where the breath sounds are weak may be the only changes found. The adventitious sounds are fine bubbling or fine crepitant râles, rarely crepitations. The physical signs are often in striking disproportion to the dyspnoea and to the extent of the lesions found at the necropsy. Other conditions which may be revealed on physical examination are the enlargement of the spleen and liver, and the presence of tubercles in the choroid. A *tâche cérébrale* may be present even before meningeal symptoms supervene.

(c) *Acute Caseous Tuberculosis*.—This condition represents the result of an infection where there is a slightly increased resisting power, and occurs in later infancy and early childhood. It is the form which frequently follows an attack of measles or whooping-cough, but often begins insidiously, though in other cases the onset may be acute or subacute. The children who suffer from this form often conform to one or other of the types formerly described as tuberculous or strumous, being sometimes of delicate appearance with clear-cut, regular features, long curved eyelashes, and fine-textured complexions, while others are coarser featured, with short, thick neck, the skin being thicker and blotchy. The clinical features of this form are in the main similar to those of the adult. There is rapid emaciation, hectic fever, and night sweats, the last mentioned being one of the earliest manifestations. The cough is troublesome, usually loose, and sometimes associated with vomiting. Expectoration may occur even in quite young children, and may be loaded with bacilli, but hæmoptysis, especially profuse hæmoptysis, is rare. Some dyspnoea develops quite early, but even until late in the disease there may be little cyanosis. The faces may be of typical hectic type, with bright eyes, flushed cheeks, and pale rings round the eyes and mouth. The hair is often lank, and soon becomes dull and lustreless. The appetite often falls early, and vomiting and diarrhoea may be troublesome, but in spite of advancing weakness the older patients in this form often present the *spes phthisicorum* up to an advanced stage. The voice is often husky or thin and piping. The physical signs are those of consolidation, and sometimes of softening and excavation, but are less characteristic than those of adults. In the lobar type the signs may be confined to one lobe or to one lung, while in the bronchopneumonic form they are more disseminated, being especially marked about the lower part of the upper lobe in front or at the root of the lung behind. The chest is often of phthisicoid type, long and narrow, with acute subcostal angle and wide intercostal spaces, the shape being more clearly recognized if the hands are raised above the head. The muscular covering shows marked wasting, and the wasting of the trapezius and of the scapular muscles is early and marked. The movements are often very poor, while flattening or local limitation of movement may indicate the side of the oldest lesion. Vocal fremitus is increased, but it is difficult to elicit unless the child says some such word as "moo" or "ma." Dullness may be localized to the upper lobe, or may occur in patches. On auscultation the breath sounds may be weak, or of broncho-vesicular, bronchial, or even tubular character; the voice sounds may be broncho-

phonic, and pectoriloquy may be obtained. The adventitious sounds may be scanty or even entirely absent, but sometimes crepitant or gurgling râles are to be heard. Cavities are usually difficult to be certain of, but can often be suspected. In the late stages some degree of clubbing of the fingers may be present. In young children this usually takes the form of slight bulbous enlargement of the ends of the fingers, not of the parrot-bill type, and the skin behind the nail is thin, red, and shiny in appearance. In the later stages of this type of the disease the skin of the trunk may become dark and rough, and a peculiar smell may sometimes be noticed.

(d) *Fibro-caseous or Chronic Pulmonary Tuberculosis*.—This form is by no means uncommon and is important to recognize owing to the relatively better prognosis if taken early and properly treated. The onset, as in adults, is very various; in some it is insidious with increasing weakness, dyspepsia, and malaise, in others with a succession of "colds," in some with a pleurisy, but in any case the child soon shows signs of ill-health. Loss of appetite, with persistent cough, and night sweats should lead to careful examination of the chest, although these conditions may be induced by many other simpler causes. A cough associated with sickness, or with expectoration, in a child under the age of 6, who has not been taught to spit out, should excite suspicion if pertussis and bronchiectasis can be excluded. The other symptoms may be similar to those of adults, but hæmoptysis is not common and is very rarely fatal, at any rate under the age of 7. The physical signs are in many respects similar to those described in the caseous cases, but they are slower in their progress and are more often apical.

Cavities, when they occur, are often situated in the lower and anterior part of the upper lobe or at the apex of the lower lobe. In cases of some duration there may be signs of bronchiectasis in the lower lobe on the side of the oldest lesion.

DIAGNOSIS.

The younger the child the more difficult, as a rule, is the diagnosis of the lesion and of its situation in an early stage, and it is necessary in all cases to consider carefully the history, symptoms, and physical signs so as to exclude other conditions with similar clinical manifestations.

In regard to tracheo-bronchial gland tuberculosis, whooping-cough has to be considered, since the character of the cough may be similar and the condition may sometimes follow on that disease. Asthma is also not uncommon even in young children, and the nocturnal attacks of dyspnoea may give rise to the suspicion of bronchial gland disease, the more so since asthmatic children are liable to become anaemic, and their chests are frequently long, narrow, and ill-covered. The repeated paroxysms of whooping-cough, the tenacious mucus brought up after the cough, as a rule serve to distinguish it, while in asthma the dyspnoea is expiratory in type, and in both conditions physical signs, if present, are those of a general bronchitis with localized collapse. Lymphadenoma and malignant disease of the intrathoracic glands may give rise to similar signs to tuberculosis of those structures, but they are so rare as to be almost negligible.

The diagnosis of miliary tuberculosis may be easy in the meningeal type, or in the other forms if tubercles in the choroid are present. In the marantic type the differentiation from the emaciation produced by congenital syphilis or chronic digestive derangements, such as vomiting and diarrhoea, may be almost impossible, and the course of the case under treatment may be almost the only criterion apart from tuberculin tests. The febrile form has to be distinguished from typhoid fever, and the appearance of rose spots or the development of the Widal reaction may be of service. The pulmonary cases may be practically indistinguishable from severe broncho-pneumonia due to other causes.

The cases of caseous tuberculosis of the lungs are usually sufficiently characteristic by the time actual signs develop, though here again the diagnosis from simple bronchopneumonia may be difficult. In the lobar type of case the onset and the physical signs may suggest an ordinary pneumonia, but the absence of resolution will soon serve to distinguish it. Sometimes the condition may closely resemble empyema, but the position of the apex beat and the absence of Grocco's paravertebral triangle of dullness at the opposite base will be of value in differen-

tiation. Certain cases of recurrent pneumonia also give rise to difficulty. Children occasionally develop signs of consolidation at one apex, which clears up but frequently recurs, the lung being eventually left in a condition of fibrosis with bronchiectasis.

The chronic form or fibro-caseous tuberculosis has to be differentiated from many conditions causing chronic cough which are not infrequently confused with it. Among such conditions may be mentioned bronchitis with localized collapse, whooping-cough, bronchiectasis and chronic tonsillar hypertrophy with adenoids. In bronchitis and whooping-cough the signs are usually general, and breath sounds are harsh, except over areas of collapse. In bronchiectasis the ruddy complexion and well-nourished aspect of the child, the basal distribution and variable character of the physical signs, as well as the peculiar metallic character of the râles, all assist in the diagnosis. The cases of adenoids with the characteristic facies and flattened chest with winging of the scapulae are, as a rule, easy to recognize, though the defective air entry may make auscultation misleading. In any doubtful case of tuberculosis the presence of obvious tuberculous adenitis or of chronic tuberculous furuncles in the skin may render the diagnosis more certain.

To establish the tuberculous nature of any case recourse may be had to examination of the sputum, to the tuberculin reaction and its modifications, or to a determination of the opsonic index. To obtain the sputum it has been recommended to recover from the stomach the mucus swallowed during the night in pulmonary cases. By some authors the faeces are examined after carbolization and repeated centrifugalization. Holt has recently shown that in a large proportion of the cases it is possible to obtain sufficient sputum for examination by irritating the pharynx so as to excite cough and then securing the material coughed up on gauze or muslin. In this manner he was enabled to demonstrate tubercle bacilli in 54 out of 67 cases.

The original tuberculin method is employed by some authors, and Schlossmann recommends it most strongly. A dose of Koch's old tuberculin varying from 0.0001 to 0.0005 gram is injected and the effect upon the body temperature observed. The usual result in tuberculous cases is that in about four to six hours there is a slow rise followed within about two to four hours by a more rapid rise, falling to normal again within twenty-four hours. Sometimes the onset of the rise is delayed and at others the reaction is more prolonged. A local reaction about the tuberculous focus may also occur, and on this account this method is avoided by many observers. It can, moreover, only be used in afebrile cases.

During the year 1907 two modifications of this reaction have been introduced. The first of these is the cutaneous reaction of v. Pirquet, who observed a small papule upon the skin within twenty-four hours after inoculating some 25 per cent. tuberculin into some scratches upon it. This reaction appears to be of value only under the age of 2 years, since after that age increasing numbers of healthy children show a positive reaction. A modification of this method introduced by Wolff-Eisler and subsequently adapted for clinical use by Calmette is known as the ophthalmic reaction. It is carried out by dropping into one eye a 1 per cent. solution in sterile water of the precipitate obtained by adding 95 per cent. alcohol to tuberculin to get rid of the glycerine. The reaction obtained in tuberculous subjects is an injection about the corneal and semilunar fold developing in from six to ten hours, but sometimes delayed to twenty-four or even thirty-six hours. In a few cases the reaction has been severe, and a conjunctivitis lasting some days has followed. M. Comby of Paris has therefore reduced the strength of the solution employed to 1 in 200, and now writes very favourably of the test. Although of so recent introduction, it has been very extensively employed, and promises to be a diagnostic measure of real value. It is wise to wait until more extended trials have been made before using it as a routine reagent; moreover, it appears often to fail in advanced cases.

Determination of the opsonic index may also be used for purposes of diagnosis, and an index much below or above the normal is suggestive, especially if modified by exercise.

PROGNOSIS.

The prognosis, which is extremely unfavourable in infancy, improves as age advances. *Post-mortem* sta-

tistics show that after the period of infancy, though a large percentage of those dying show tuberculous lesions, decreasing numbers die from that disease, and that there is an increasing tendency for reparative processes to develop. In miliary cases and in many of those of caseous type the outlook is almost, if not quite, hopeless when once the disease has become established; but it must be remembered that these are cases in which the protective processes have broken down and allowed of dissemination of the lesions, and that if they had been recognized at an earlier stage the prognosis might have been different. There is no available material for forming an opinion as to the prognosis in cases of tracheo-bronchial gland infection, but in view of the frequency with which old lesions are found in this situation, it is probably not unfavourable in many cases, although the presence of lesions there is a grave danger in early life from their liability to lead to general infection. In fibro-caseous cases in later childhood the outlook is distinctly favourable in a good proportion if recognized early and properly treated, although to forecast the prognosis in any individual case is a matter of extreme difficulty. In many cases, however, the process of arrest seems to be complete.

TREATMENT.

Owing to the great susceptibility of infants and young children, preventive measures should be most rigidly carried out. French authors insist on the importance of recognizing and dealing with what they call the "pretuberculous" conditions, that is, those in which the conditions are favourable to infection, and possibly also those in which infection has just occurred. From what has been discussed in regard to etiology, it is obvious that prophylactic measures must be mainly directed to preventing the child from coming into relation with sufferers from open tuberculous lesions, and to ensuring that the diet is beyond suspicion. If there is a tuberculous subject in the family, the most careful precautions must be taken to avoid infection, and it is especially necessary to see that the nurse or the domestic servants who come into relation with the child are free from the disease. Kissing by strangers should be prevented. The most strict cleanliness in regard to the infant is essential, and it should be brought up in the healthiest surroundings possible. If milk is given, the source should be known, or the milk should be pasteurized or sterilized. By such means it should be possible in most cases to prevent the disease in infancy.

Owing to the grave nature of miliary and caseous cases their treatment is largely palliative and symptomatic. The curative treatment of intrathoracic tuberculosis in children practically resolves itself into the care of the bronchial gland and the chronic lung cases, and on the whole the treatment of these is practically identical. Directly the condition is recognized the child should be removed from school, and if living in a town it should at once be sent away. Provided that the place chosen is warm, equable in temperature, and fairly dry, the choice between sea, inland, and mountain is not a matter of vital consideration. The question of the care of the children suffering from tuberculous disease has been taken up with great public spirit in France, where sanatoriums have been instituted in many places, especially about the coast, with excellent results. As far as possible the different types of cases are separated, and especial attention is devoted to the "pretuberculous." Novi and Gonrichon state that pulmonary cases gain in weight less in maritime colonies than in mountain or simple country districts, and this seems to be the general opinion. Early cases, however, seem to do quite well, and the value of seaside resorts, especially those about Margate, in the treatment of chronic joint cases is well known in this country. Some German authors recommend Davos. Except under exceptional circumstances it is impracticable to send children from this country; moreover, they appear to do better in warm than in cold climates. It must be urged upon the parents that a few weeks' stay at the seaside or at a health resort, the child being allowed to live almost as other children, is of little value; the life of the child must be as rigidly mapped out as that of an adult in a sanatorium and on somewhat similar lines, while the stay should be prolonged for months or even to a year.

If the arrest is to be permanent. If there is fever, the child must be kept in bed until the temperature is steady. The rooms in which the child lives and sleeps must be bright, sunny, and well-ventilated. Rest, especially before meals, in cases not confined to bed is important; the amount of time devoted to play and exercise must be carefully controlled. The question of breathing exercises has been much discussed; my own opinion is that, at any rate in early cases, they are of value and should be encouraged.

In regard to diet, this should be liberal, and rich in milk, cream, and other fatty constituents. Food should be given at regular periods, and the intervals should not be long. Children, however, do not stand over-feeding very well, and it is best, by abundant open air and gentle exercise, to promote healthy appetite. A raw-meat diet is highly recommended by some authorities, and is well borne by many children. Drugs are but little needed; cod-liver oil in emulsion with malt, or some iron wine or other preparation may be given; arsenic is recommended by some authorities, and may be given in the form of one of the natural arsenical waters. The syrup of the iodide of iron is recommended, especially in the cases of tracheo-bronchial gland infection. Creosote and other antiseptic preparations I have not found it necessary to give internally. If the cough is troublesome, it may be allayed by a simple linctus or a small lozenge. If of paroxysmal character, an inhalation made of creosote and spirits of chloroform, a few drops being sprinkled on lint, is sometimes very useful. Other symptoms may be treated on much the same lines as in adults.

In regard to specific treatment, some trial has been made of the use of tuberculin in these cases. It should only be given where the disease is strictly localized, and only in very small doses, its effects being carefully followed by means of determinations of the opsonic index. A high index or a markedly fluctuating index is probably to be regarded as a contraindication, since it means that auto-inoculation with toxins is in active progress. Ganghofner of Prague reports favourably on the employment of Koch's old tuberculin in a few cases. He commenced with 0.1 mg., but subsequently reduced the initial dose to 0.01, increasing slowly by $\frac{1}{1000}$ mg. till 1 mg. or more was reached.

The tracing of opsonic curves by Wright's method shows that in the past much too large doses have been given, and Dr. Olive Riviere recommends doses of $\frac{1}{1000}$ to $\frac{3}{1000}$ mg. for infants up to the age of 1 year, $\frac{1}{1000}$ at the age of 4 years, and $\frac{3}{1000}$ at 10 years. This treatment can at present only be employed in a few cases owing to the labour and time involved in the opsonic determination, but it promises to be of real value, and may at any time become of more general application if a simpler measure of its effects than the opsonic index be found.

To sum up. The aims of the practitioner should be in the first instance to prevent infection; failing this, to establish the diagnosis as early as possible, and to employ every available means of improving the general health of the child with the object of increasing its protective powers. Under such conditions, the outlook in a considerable proportion of the cases is distinctly favourable.

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An Address

ON THE

MODERN TREATMENT OF SURGICAL TUBERCULOSIS.

DELIVERED BEFORE THE WINDSOR MEDICAL SOCIETY.

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By the term "surgical tuberculosis" I mean the infection by tubercle of such organs as the bones, the joints, the lymphatic glands, the skin, the genito-urinary system, the peritoneum, and certain abdominal and pelvic viscera, the treatment of all of which usually falls within the province of the surgeon.

During the last decade there has been a slow but steady improvement in the treatment of these conditions. In this improvement the clinicians and hygienists were, at first, our leaders; but lately the pathologist, in the person of my friend and colleague, Sir Almroth Wright, has brilliantly intervened, and has not only supplied us with scientific explanations of the success or non-success of our empirical methods, but has also made valuable additions to our therapeutic resources.

The main principle underlying the modern treatment of tuberculosis is that the ultimate cure of the disease depends upon the elaboration by the individual attacked of certain protective substances in sufficient quantities to render innocuous the invading organisms. This protective mechanism is highly complex, and it is easily influenced for evil; but, on the other hand, it may be augmented by certain measures, some of which are the outcome of pure empiricism, while others are the result of deliberate experiment and research. Of late years it has been realized that Metchnikoff's theory of phagocytosis is not the whole truth as regards the mechanism of protection against bacterial invasion. The protective mechanism is a more complex one, including the chemical action of certain antibacterial substances in the serum and tissue fluids in addition to the vital activities of the phagocytes. These protective substances exert their influence by combining with the chemical constituents of the bacteria, and are called bacteriotropic substances. According to the effect which they produce, they are called agglutinins, bactericidal substances, and bacteriolysins. To these Wright has lately added the term "opsonins." The function of the latter is to prepare the bacteria for ingestion by the phagocytes. This has been demonstrated by a simple experiment. If white corpuscles be washed with isotonic salt solution, so as to free them entirely from serum, the corpuscles will no longer ingest bacteria; but they will do so at once in the presence of normal serum. Wright and his colleague Douglas, in addition to demonstrating the presence of these bodies, have also devised a method of estimating them quantitatively.

The method employed is to incubate for fifteen minutes at 37° C. a mixture made in a capillary pipette of equal parts of

1. Washed corpuscles, freed from all traces of plasma.
2. Emulsion of micro-organisms.
3. Serum from the patient whose blood is to be tested.

The micro-organisms ingested by 100 polynuclear leucocytes are then counted and compared with a number found in 100 leucocytes in a film made from a mixture composed of

1. Washed corpuscles.
2. Bacterial emulsion.
3. Serum of a normal individual.