THE EARLY DIAGNOSIS OF TUBERCULOSIS IN SCHOOL CHILDREN.

THESIS

for

Degree of M.D. Glasgow,

by

Percy Bellwood Farrar, M.B., Ch.B.

ProQuest Number: 27660863

All rights reserved

INFORMATION TO ALL USERS
The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript
and there are missing pages, these will be noted. Also, if material had to be removed,
a note will indicate the deletion.

ProQuest 27660863

Published by ProQuest LLC (2019). Copyright of the Dissertation is held by the Author.

All rights reserved.
This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

THE EARLY DIAGNOSIS OF TUBERCULOSIS IN SCHOOL CHILDREN.

PART I. - I N T R O D U C T I O N.

MORTALITY and MORBIDITY of TUBERCULOSIS.

Of all the problems the Student of State Medicine has to face, there can be none so far reaching in its importance, so baffling in its difficulties, so tremendous in its influence on mankind, as the question of tuberculosis in the young. From the time when a child comes into the world, - some would even say before that, - he is plunged into a mighty conflict between his own peculiar lines of defence, and the omnipresent, cir-:cumambient Tubercle Bacillus. How fierce the fight is may be judged from this fact, that tuberculosis, latent or active, seems to exist in the body of every child. In the general population the ravages of this disease can be definitely traced in a very large proportion of people. What this proportion is has long been the subject of discussion, and many and varied are the estimates of different observers.

Osler claimed that 90% of the population possessed latent Tubercle, saying that "so widespread is the germ, that practically all humans, by the time they become/

become adult, harbour the bacillus of the disease." Nägeli, from observations during a series of Autopsies, gives the figure as 97%, and Reinhart, from a similar series, as 96%. The figures culled from vital statistics most undoubtedly err on the small side, for they show only such cases as are certified as having died of Tuberculosis. Many cases in which a tuberculous element is present will appear as:- "Whooping-Cough," "Bronchitis," "Pneumonia," "Empyema," while cases showing no lung involvement will appear as "Ascites," "Meningitis," and so on. Furthermore, many cases dying of some intercurrent disease would, at post-mortem, have demonstrated latent or healed tubercles.

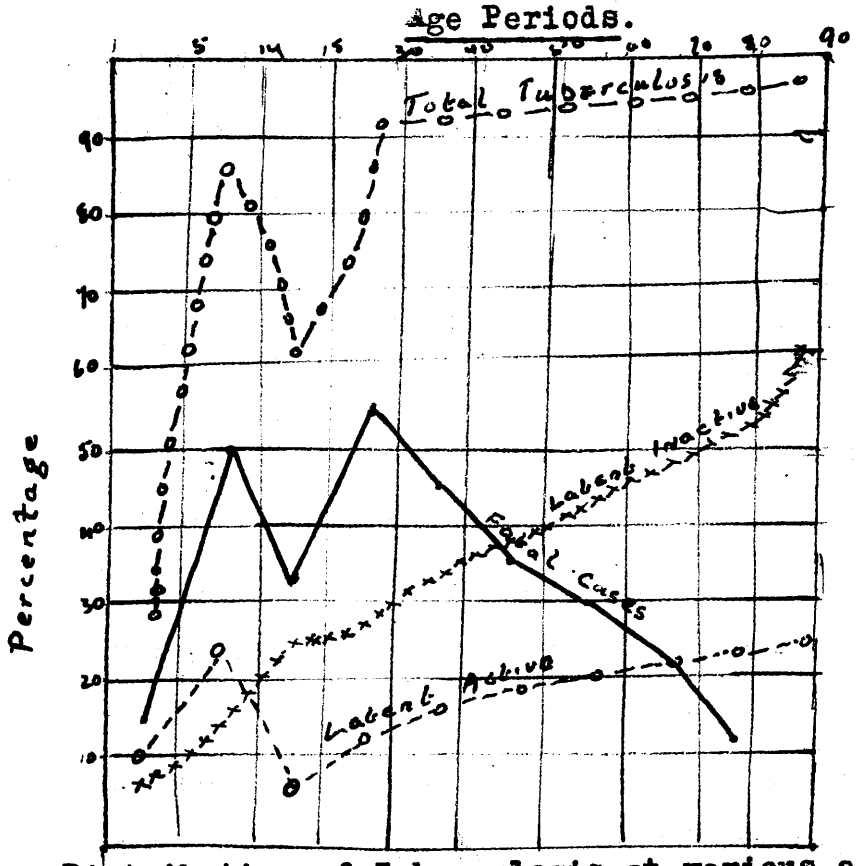
The only method of gaining reliable information, and of drawing legitimate conclusions, would be to make records of autopsies of every person who died. But a very small proportion of mankind come to the post-mortem room, and public opinion would require to be very much modified before such an ideal as that stated above, could come within our reach. The proportion of bodies examined to the total population, varies considerably in different countries. In some of the European States all those dying on Hospital are examined, but here again, the data are scarcely reliable. Those persons who end their days in Hospitals/

Hospitals are of the poorer and working classes, and the figures are not a true reflex of the state of the whole population. At the same time, it is among such classes that tuberculosis is most frequent, and therefore such statistics form the best available basis for conclusions.

Even the records of a long series of autopsies cannot be looked upon as thoroughly reliable. Unless a report definitely states that tuberculosis was not present, unless the observer is specially trained, and is making in each investigation a diligent and exhaustive search for lesions, the report, from a statistical point of view, is valueless and negligible. This fact, together with newer and more comprehensive classification probably accounts for the figures of Nägeli, Reinhart, and Burkhardt (vide infra), being substantially greater than those of earlier investigators. Burkhardt carried out his investigations in autopsies on 1452 persons dying of various diseases, his classification embracing, besides (1) lethal tuberculosis, (2) "latent active" tuberculosis, which was not the cause of death, and which included all fresh caseations in lungs, glands or elsewhere, and (3) "latent-inactive" tuberculosis.

His findings are graphically represented in the/

the accompanying figure, showing the distribution of tuberculosis in the various age groups. Here it will be seen that the findings so far correspond with mortality statistics, that the maximum danger from tuberculosis is during the most active period of life viz: from 18 to 30 years of age. A divergence from mortality table findings, however, is found in childhood where, in this series, a heavy incidence and mortality occurs in the age-group 5 to 14 years.



Distribution of Tuberculosis at various age periods in series of 1400 autopsies (per 100 cases at same age).

The uppermost line in the graph, representing total tuberculosis findings, shows that a steady increase in the number of persons infected takes place after the age of 20 years, while the continuous line representing fatal cases, shows that over the same period a steady decrease in mortality takes place. The three curves representing respectively, Total Tuberculosis Findings, Fatal Cases, and Latent Active Cases, all agree in this point, that in childhood there is a period of rapid increase up to twelve or thirteen years, after which is a rapid fall, till about sixteen years, when a further rapid increase lasting till twenty five years of age takes place.

The conclusion to be drawn from the figures examined is that practically every individual, at some time in his life, acquires the infection although a proportion only of these may ever require medical attention for this disease.

In the year 1920, the death-rate per 100,000 in England and Wales, from all forms of tuberculosis, was 113; in Scotland 124; and in Ireland 171. For the same year, the death-rate per 100,000 from all causes, in England and Wales is set out in the following table.

Measles 19
Whooping Cough 12
Influenza/

Influenza	28
Cancer	116
Organic Heart Disease	141
Bronchitis	99
Pneumonia	99
Other Respiratory Diseases	17
Old Age	67
Violence	47
Other Causes	481
Total	1126

Thus, the total number of deaths from all causes was 1239, and the percentage of all deaths due to tubercul-:osis 9·12%. It is advisable for our purpose here to analyse these figures, and find how they are apportion-:ed over the various age groups. The following table sets out the death rate per 100,000 of population from tuberculosis in each age group:-

All Ages	Under 1 year	1-5	5-10	10-15	15-45	45-55	55-65	65-75
113	163	106	43	49	135	147	120	98

Such statistics furnish us with a working frame on which to base our conceptions of the havoc wrought by tuber-:culosis in the human population, but there can be little doubt that they greatly understate the true facts. For example, a large number of children are certified as dying of broncho-pneumonia, where the broncho/

broncho-pneumonia cloaks an acute tuberculosis. Sir Robert Philip claims that, by multiplying the death-rate figure by a number somewhere between 10 and 20, we shall arrive at a fairly just estimate of the number of cases that will require medical surveillance with a view to treatment and prevention, while a still larger proportion of the populace will stand in need of more general preventive measures. The findings of Nägeli, Reinhart, and Burkhardt amply confirm this contention.

PREVALENCE in CHILDHOOD.

There is a concensus of opinion that infection is mainly acquired in child-hood. This question has received considerable attention of late years, but the results of various investigators are very diverse. The sources of this error are many. Thus, different workers have different methods, work with different material, and under different local conditions, while not all of them have the same proportion of children of various ages, and especially of infants under one year.

Some of the findings of eminent workers are set out in the following list from Klebs "Tuberculosis":-

Authors/

Authors	Age	Autopsies	Numbers of Tuberculous	Percentage Tuberculous
Muller (1889)	0-15 years	500	209	42
Councilman &c. (1901)	?	220	35	16
Baginski (1902)	?	806	144	18
Orth (1904)	0-15 "	435	43	10
Nageli (1900)	0-15 "	88	15	17
Burkhardt (1906)	6 weeks to 15 "	190	72	40
Hamburger and Sluka (1905)	0-14 "	401	160	40
Hamburger-Ghon (1907)	0-14 "	848	335	40
Sehlbach (1908)	0-14 "	1423	180	13
Beitzke (1909)	0-15 "	397	54	13·6

Klebs points out that, if children under one year are excluded from many of these numbers, the percentage of tuberculous children substantially rises.

Before the age of six months, tuberculosis is rare. Still, in the analysis of post mortem records in the Hospital for Sick Children, shows that only one case occurred before the age of three months, while 130 or more than 25% occurred during the second year of life. He shows further, that, of all the deaths in the Hospital, about 30% were due to tuberculosis. Sir Robert Philip likewise states that, in an examination of school children in Edinburgh, at least 30% showed definite evidence of tuberculosis. If such a figure is arrived at

on/

on clinical grounds alone, how much greater must the figure be when Tuberculin Tests, Laboratory Methods, and the Radiograph are brought to the aid of hand, eye, and stethoscope? Again, how many more, on the post-mortem table, would reveal the tombs of dead or latent foci?

The discovery of Tuberculin Reactions and their application by careful workers has made it more possible to determine the full extent of the danger. Von Pirquet found that practically all adults react to the tests, proving that almost everyone, at some time, becomes infected. In his experimental work upon children he brings out some interesting points. He finds that the percentage of children reacting rises from 5% in the first year to 80% in the tenth and eleventh years, while the percentage of those showing clinical signs is distinctly below this figure. At the same time, the two figures more nearly approximate in the earlier years, showing that latent tuberculosis increases as age advances. This result coincides with that depicted in the graph of Burkhardt's results in autopsies.

It is thus evident that tuberculosis is essentially a disease of early life. The highest mortality is to be found in the most active years of life, and we are forced to the conclusion that has been arrived at by Von Pirquet, Calmette, Ganghover, and others, that nearly all children become tuberculised

before/

before they attain the age of 15 years.

An analysis of 180 consecutive cases of all forms of tuberculosis notified in the Burgh of Arbroath gives the following figures for each age group:-

0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45
16	19	15	22	20	13	14	13	11

45-50	50-55	55-60	60-65	65-70	70-75	Over 75
13	10	7	1	3	2	0

If these cases be separated into pulmonary and non-pulmon-:ary tuberculosis, the figures are as follows:-

A. Pulmonary:-

0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
2	5	5	11	14	9	9	7

40-45	45-50	50-55	55-60	60-65	65-70	70-75
7	12	8	6	1	2	2

B. Non Pulmonary:-

0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
14	14	10	11	6	4	5	6

40-45	45-50	50-55	55-60	60-65	65-70	70-75
4	1	2	1	0	1	1

Worked to percentages, in age-groups of ten years:-

Ages/

Ages	0-10	10-20	20-30	30-40	40-50	50-60	60-70	Over 70
Pulmonary	20	43·2	69·7	59·3	79·2	82·4	75	66·7
Non Pulmonary	80	46·8	30·3	40·7	20·8	17·6	25	33·3

These tables are in accordance with the general finding that tuberculosis is most prevalent in young persons and that non-pulmonary varities are especially common in chil-:dren. 40% of all the cases occur in the first twenty years.

There must be some welldefined reason for this high incidence of the disease during the growing period of life, and, if we are to prevent serious consequences, it is our duty to determine what that reason is. It is a very difficult matter to trace the channel of tuberculous infection in childhood, principally because of the great liability of young children to an acute generalised disease. Wherever the bacilli establish themselves they penetrate the mucous membrane of that part. In the child, mucous membrane is especially receptive and the organisms have an easy entrance. Thence they reach the nearest lymph glands. These structures act as the first lines of defence, and, at the commencement, they mechinically arrest the bacilli. In childhood, the lymphatic system throughout the body constitutes a highly developed and potent organ.

Lymphatic glands are round or oval bodies, of varying/

varying size, but not as a rule larger than a bean. They are interposed on the course of lymphatic vessels, and through them the lymph passes to be discharged into blood-vessels. The interior of the gland, within its connective tissue, consists of two parts, a light-coloured outer or cortical part, and a redder inner or medullary part. From the hilus, processes of the capsule – trabeculae-containing the blood vessels, proceed into the gland. In the cortical part, the intervals between them are large (alveoli) while in the medulla a fine network of anastomoses is found. Lymphoid tissue occupies the alveoli and trabecular network of the medulla, leaving around it a lymph space. The afferent vessels which carry lymph into the gland, when they reach this lymph space, have only one coat, the endothelium.

One of the main functions of these glands is to act as filters. Here many of the dead and effete erythrocytes, discarded by the blood in its ordinary physiological processes, are arrested and destroyed. Here too, the phagocytes set upon, and attempt the elimination of such foreign bodies,-e.g. bacteria, - as are carried to them. When the bacillus tuberculosis gains entrance to the body at some point, an effort is made to destroy it. So long as the numbers are small this may be possible, but at the same time, the organisms have found a suitable culture medium, and multiply. Their growth, and/

and physiological excretions or secretions, stimulate the defencive forces of the glands to activity, and antibodies are formed. However, as will be pointed out, the tubercle bacillus is protected by a coat of some wax-like material, and is very resistant. In many cases, the most that can be done is to check the activity of the organisms and they become, as it were, "interned."

Mechanical arrest of this nature cannot be maintained for long and soon the strain becomes too much for the glands. The infection passes on, and vital organs are attacked. In very young children, this results frequently, in hydrocephalus, - the clinical sign of an acute general (miliary) tuberculosis. When such cases are examined post-mortem, it is often, - indeed in the majority of cases, - observed that miliary tubercles are to be found all over the body, only those in the meninges being sufficiently near vital structures to produce the rapidly fatal result.

In older children the rôle of the glands is greater. One of two things may happen consequent upon the primary infection.

On the one hand, as a result it may be, of repeated inoculation, the child develops a certain amount of immunity, and the local lymphatic glands may be able to/

to cope with the infection. Here, by reason of the digestive processes at work, the cells surrounding the bacilli become liquified and destroyed, but the whole process becomes encapsulated, existing always as a source of danger, from which, in the future, may arise acute and widespread tuberculosis. In the present limited state of our knowledge it is not possible to distinguish this process as a clinical entity. That it must have some effect upon the child's general health cannot be denied, but it seems highly probable that many of those inexplicable pyretic attacks in children are due to some such cause. Everyone is familiar with the case of the child who for days was "out of sorts", tired, disinclined for food, when no clinical signs whatsoever could be detected. Here may be the explanation. Again, those children that harbour such a latent focus in their bodies, may include the vast army of the pale, thin, lackadaisical, with whom their mothers declare "there is never anything wrong." Certain it is, that these constitute a large proportion of the population who give a positive tuberculin reaction.

On the other hand, a large number of children do not escape so lightly. In them the glands which seek to stem the tide of advance of the tubercle bacilli become/

become totally destroyed. The disease may, for very long periods, remain localised in the glands, and spon-:taneous recovery may take place. More commonly, other glands become infected, and frequently spread takes place to other and more vital organs. Two sets of processes may be observed in the lesions, (1) destructive changes produced by the bacilli, and (2) reparative changes pro-:duced by the tissues. The ultimate result depends upon which of these two processes gains the mastery. On the one hand, the bacilli are producing necrosis, caseation, softening; on the other, the tissues are attempting to localise the lesion by proliferation of cells, and overgrowth of fibrous tissue.

At first the glands are simply enlarged, and resemble on section, normal glands that have undergone hypertrophy. Shortly, however, small whitish nodules appear. These enlarge and soften, and sooner or later the whole gland becomes soft and semi-fluid. In some instances, when the resisting power is sufficiently strong, or the virulence of the germ sufficiently weak, the process is arrested; a tremendous hyperplasia of glandular cells takes place, and frequently lime salts are deposited.

It appears, therefore, that infection having been acquired, there are two distinct stages in the disease/

disease. In the first stage the lymphatic glands become affected, the disease in them being either apparent clinically, or non-apparent. The disease may stop here, or proceed to its second stage, either an acute miliary (generalised) tuberculosis, or tuberculosis of one or other of the vital organs, e.g. the lungs. The frequency of infection increases as the child grows older, but the progress of the disease is less rapid, the resisting power of the individual appearing to grow stronger. This may be due to the fact that frequent and repeated inoculation with small doses of the virus, confers some degree of immunity.

CONGENITAL TUBERCULOSIS.

INFLUENCE OF HEREDITY.

The occurrence of "congenital tuberculosis" has given rise to much discussion, even from the time of Hippocrates. In the medical profession the view has its adherents and its antagonists; in the lay mind, it is, all too unfortunately, an established fact. It has been proved beyond doubt, that among cattle it does certainly occur, unmistakable tubercles, the nature of which was proved by bacteriological methods, having been demonstrated in a bovine foetus. Medical literature

does/

does not record any authentic cases in the human subject, but how often does a human foetus come under the scrunity of the Pathologist? In arriving at an opinion, we are reduced to judging on clinical evidence and family history alone. There are in this matter two distinct beliefs. On the one hand is the claim that the germ of the disease is transmitted from parent to offspring, and on the other that only a "tendency" or "predisposition" to the disease is inherited. By those who believe that the germ is inherited, it is claimed that much of the latent tuber-:culosis lighting up in later years, has been present since before birth. The difficulty met with in attempt-:ing to solve this problem, is in being able to establish, beyond doubt, the distinction between infection and heredity. There is yet another point of view, namely, that what is inherited is a tendency to disease in general. According to this premise it is not necessary to find actual tuberculosis in one or other of the parents. Certainly, in studying family histories, it is a common thing to find bronchitis, asthma etc. affecting several members of a family, one of whom only, shows definite tuberculosis of the lungs.

The following three cases serve to illustrate the difficulties attending this question. -

CASE/

CASE I. The family consists of father, mother, and four children. The father is a thin man, not particularly robust, but apparently healthy. The mother is a sufferer from bronchial asthma; the eldest child, a boy, has a lesion in his right lung; the second, a girl, is of a weakly constitution, but shows no active disease beyond otitis media, which I believe should always be regarded as a danger signal; the third, a boy, had tuberculous glands about the same time as the elder boy first complained of lassitude, and slight cough, and now suffers also from bronchial asthma. The youngest child, aged two years, has, since birth, had several attacks of bronchitis, but is growing and thriving well.

CASE II. A woman of 32 years of age suffers from pulmonary tuberculosis. A sister died of pulmonary tuberculosis thirty years ago, but no other case can be traced in the family history.

CASE III. This family consists of father, mother, four sons, and one daughter. The mother died of tuberculosis of the lungs at the end of 1924 after an illness of two to three years duration. One son suffers from pulmonary tuberculosis, advanced; another has a healed lesion in one lung; a third suffered from tuberculous disease of the elbow; the daughter - the youngest/

youngest of the family - has a tuberculous knee joint; the fourth boy has bronchitis every winter. In this case the father is a stout, powerful plethoric man.

INFLUENCE OF INFECTION.

If the part played by heredity in the perpetuation of this dreaded disease, remains in the limbo of uncertain things, the role of infection is now well established. It was due to Robert Koch that the whole scientific outlook on tuberculosis was changed, and set upon a sound foundation. Koch was born at Klausthal on the Harz in 1843. Always a master of laboratory technique, he was, as a result of his researches on wounds, septicaemia, and splenic fever, appointed to the Imperial Board of Health in 1880. Two years later, his discovery of the specific germ of tuberculosis was announced. In 1884 he published the full account of his work. This work will always remain as a masterpiece of scientific research, for not only did Koch surmount many and great difficulties in isolating, demonstrating, and cultivating the bacillus, but his proofs of the relations of organism to disease were so complete that subsequent workers have been able to do no more than repeat his experiments and confirm his results.

THE BACILLUS.

The organism which he discovered could not be stained by the ordinary methods, and it was only after staining for twenty-four hours with a solution of methylene-blue to which caustic-potash was added, that he was able to demonstrate the bacillus. Again, its cultural properties differed from those of other organisms of Koch's acquaintance, and he only succeeded in growing his bacillus on a medium of solidified blood-serum, devised by himself. This organism, now universally known as the Bacillus Tuberculosis or Tubercle Bacillus, is a small, red-shaped bacterium, measuring u 2·5 to u 3·5 in length, and about u 0·3 in thickness, though longer forms are sometimes met with. They are straight, or slightly curved, and, though generally occurring singly, two may be attached end to end, usually to form an obtuse angle. They stain uniformly as a rule, but forms with a beaded appearance occur in preparations, both from tissues and from cultures. Koch looked upon these beaded forms as showing evidence of sporulation, but experiments do not confirm this suspicion, and at present their significance is not known. True chains are not formed, and the organism is non-motile.

As already stated this organism has always proved/

proved difficult as regards staining reactions, for it takes up stains slowly, and, for successful demonstra-:tion, a powerful solution must be used, e.g. Fuchsin or Gentian - Violet, with Aniline-Oil water or Carbolic Acid. Prolonged immersion in the stain or the gentle application of heat till steam arises, the specimen remaining in the hot solution for two or three minutes, is necessary. At the same time, the organisms, once stained, resist decolorisation by those solutions which readily remove stain from tissues and other bacteria. Thus, the preparation may be decolorised by Nitric Acid, Sulphuric Acid, or Hydrochloric Acid in 20% solution, and, if desired, the tissues may be counter-stained a different hue. Erlich was the first to apply this method with success. Various adaptations of the general principle have been devised, one of the best methods for practical purposes, being the Ziehl-Neelsen, which is as follows:-

A solution is used consisting of:-

Basic Fuchsin 1 part

Absolute Alcohol 10 parts

1 in 20 Carbolic Acid Solution 100 parts.

(1) In this solution the specimen - film or section - is placed, and heat applied till steam rises, after which it is allowed to remain immersed for five minutes. (2) The/

The specimen is decolorised with 20% solution of strong Sulphuric Acid, Nitric Acid or Hydrochloric Acid, the tissues becoming yellow. (3) Water is used to wash the preparation, the tissues now becoming faint pink. For half a minute alcohol is used for washing and the slide replaced in water. (4) Counter-staining with saturated aqueous solution of methylene-blue may then be carried out, half-a-minute being required, or, if Bismarck-Brown be used, two to three minutes. (5) A film may then be simply washed with water, dried and mounted, or a section dehydrated and cleared before mounting.

This peculiarity of reaction to stains is held in common with certain other bacilli, and to this group the term "acid-fast" is applied. Much maintained that the Bacillus Tuberculosis in addition to the ordinary acid-fast type, exists in a form not acid-fast, and also as free granules. These are demonstrated by modifica-:tions of Gram's method.

No less than the difficulty of staining, has been the difficulty of cultivating on artificial media. With Koch's inspissated blood-serum, growth does not appear for ten to fourteen days after inoculation. Then it shows as minute points of dull-whitish colour and slightly raised. Sub-cultures generally grow better than the original. In addition to this medium,

egg/

egg, and glycerin-egg media give good growth, while agar and gelatin-agar give no result. On glycerin-agar a good culture is generally produced, and growth in sub-cultures takes place much earlier and more rapidly than on serum. It is not, however, a good medium for making cultures from the tissues. On glycerin-potato and glycerin-broth, however, the organism flourishes well, even in direct inoculation from the tissues. Frugoni has introduced a medium containing fragments of animal tissues, e.g. rabbits' lung in glycerin-bouillon, and these media yield luxuriant growth.

The optimum temperature for cultivation is 37 °C to 38 °C, the minimum 28 °C, and the maximum 42 °C. That is to say, the tubercle bacillus grows only at body temperature. These organisms stand cold well, but are readily destroyed by heat. Exposure for four to six hours to a temperature of 55 °C is sufficient to kill the bacillus, while at 90 °C, two minutes suffices, and a still less time at the boiling point of water. Dried bacilli are even more resistant than those in a moist state. Completely dried they can resist a temperature of 100 °C for an hour. When not exposed to extreme temperature, completely desiccated tubercle bacilli survive for long periods. Thus is has been proved that dried phthisical sputum will remain virulent for six to eight weeks. The peculiarities

of/

of chemical composition may explain this fact. MacLeod and Bulloch by treating tubercle bacilli with hot alcohol and ether, extracted a wax, which gave the characteristic staining reactions of the bacilli themselves. The remains of the bacilli, when treated with caustic potash, yielded a body, probably a chitin, which was acid-fast when treated with carbol fuchsin for twenty-four hours. At the same time, antiseptics destroy the germs with relative ease, in vitro, and the action of direct sunlight has again and again proved to be very inimical to them. Free air is to a lesser degree lethal, and where this has been excluded, grganisms have been found virulent after four or five months.

HISTORY OF INFECTIVITY THEORY.

Koch, by his discovery, only proved the truth of the opinion held by many earlier workers from Hippocrates downwards that tuberculosis is an infective and communicable disease. Hippocrates, (460-376 B.C.) who described the symptoms of phthisis with remarkable clearness recognised that a certain type of individual appeared more prone to fall victim to the disease, and that the infection might be communicated to other

persons/

persons. Galen (130-210 A.D.) in his voluminous writings sets forth as his opinion that the probability of acquiring infection from a tuberculous individual is such, that it is dangerous to spend even a single day in the presence of a sufferer. The Arabian philosopher and physician Avicenna, who was born near Bokhara 980 A.D. and died in 1037 A.D. and whose medical writings were long the standard, referred to phthisis as being "taken from man to man." Later, in the fifteenth century, the frequent occurrence of tuberculosis in those who attended consumptives, was noted by Ballonius of Paris, while the well-known founder of pathological anatomy, Morgagni (1682-1771), considered that the pathologist ran grave risks of infection in conducting autopsies on persons who had died of this disease.

The first legislation affecting this question was introduced in Italy by Ferdinand VI in 1746, and this was rapidly followed by the adoption of similar measures elsewhere. So far, all the views on the subject looked upon the sources of infection as the clothes, bed-linen, drinking vessels, and the breath of the diseased individual, it being thought, in regard to the last item, that the mere inspiring of air exhaled by a consumptive was sufficient to determine an attack of the disease. During the last century a reaction set/

set in, and the disease was looked on as non-infective for a considerable time.

Probably the first worker to bring forward experimental evidence in support of his view was Kortum, who, in 1789, attempted inoculation experiments. J.A. Villamin, a French Army Surgeon, (1827-1892), in a paper to the Paris Academy of Medicine, December 4th 1865, and in a work "Etude Sur la Tuberculose," in 1868, maintained that the disease was a specific infection, and showed the results of inoculation of tuberculous material into susceptible animals to prove his contention.

A summary of his conclusions is as follows:- (1) That the inoculation of tuberculosis material into susceptible animals is followed by tuberculosis. (2) That the lesions are similar to those of tuberculosis naturally acquired, (3) That the inoculation of matter which is non-tuberculous does not produce such lesions, and (4) That the source of the tuberculous matter, i.e. whether human or bovine, is a matter of importance in the results. Prior to this, viz: in 1843, Klencke had made some successful inoculation experiments in support of a similar view. Cohnheim in 1877 elaborated these experiments, and finally established the inoculability of the disease, while Klebs succeeded in carrying/

carrying out feeding experiments and actually in cultivating a virus on artificial media of egg-albumen.

Other workers who had demonstrated the infective nature of the disease were Armanni and Salamonsin, who showed that when the anterior chamber of the eye of a rabbit was inoculated with tuberculous material, after an incubation period of about twenty-five days tuberculous nodules appeared on the iris leading to destruction of the eye, and finally to the death of the animal from acute general tuberculosis. Others again have succeeded in transmitting the disease experimentally, by inhalation and ingestion.

The organism of Koch, has accordingly been proved to fulfil the essentials of a specific bacillus i.e. (1) This organism can be isolated from all cases of the disease (2) Cultures can be made from the diseased tissues, and subcultures thereafter, (3) Organisms from the subcultures are capable of reproducing the disease, having the same characteristics as the original lesions.

It is not possible to produce statistics to prove the extent of the infectivity of this disease. So many cases that at post mortem show signs of tuberculous lesions have probably never been infective, that we can form no very definite conclusion as to the number/

number of cases that each person will infect. From a careful study of case-histories, however, we can learn the fact that one case may infect several persons, and from this, arrive at some idea of the extent of the danger. At the same time, it is much more difficult to trace the source of infection in tuberculosis, than in most of the acute infective diseases, principally owing to the long period of latency. Case III already referred to most probably shows the results of an infection rather than of heredity. It was difficult here to determine which member first showed evidence of the disease, the mother being the last to be notified, although it transpired that she had complained of cough for a very considerable time before that. The small girl suffering from disease of the knee-joint was stated to have been the first, and to have acquired the infect-:ion from milk. At any rate, another child who was fed with milk from the same dairy was found about the same time to have developed a tuberculous lesion.

Another interesting history is to be found in Case IV, that of a girl with pulmonary tuberculosis, the onset of which can be definitely determined, since the initial symptoms were those of pleurisy. The mother of this girl died of phthisis; the father, after remarriage, contracted the disease and died, and subsequently/

subsequently the step-mother was found to have a chronic lesion. There can be no question that this history shows direct infection in the home.

Three other cases serve to illustrate this point:- Case V, a woman aged 50 years developed tuberculosis of the lungs in 1920, and died in September 1922. Her son was notified in July 1923, and died four months later, the disease appearing from his history to have commenced a considerable time before the notification. In September 1923, his aunt, sister of the first patient, who had lived in the same house throughout, developed definite clinical signs.

Case VI illustrates infection between husband and wife. The first to be notified was the husband in January 1922, his history being that he developed a "cold" on the 17th of that month and grew steadily worse. He died in March 1923. The wife was notified in March 1922 her history showing a gradual onset from about Christmas time 1921. Prior to this she had four times had pleurisy. The probability in this case is that the wife had harboured a tuberculous lesion which did not show clinically, but which was sufficient to infect the husband.

Case VII. The mother of a grown up family died of phthisis and within six months the eldest daughter who, at the time of the mother's death, was well and residing/

residing at home, also died of a very acute pulmonary tuberculosis. Five months subsequently, the youngest daughter complained of a swelling in right axilla which proved to be a tuberculous abscess. It was elicited in the history that she had had a cough for three weeks, and a consolidation of right lung was discovered, accompanied by considerable fever. She went to stay with a married brother in the country, contrary to advice. In two months she returned and died three weeks afterwards. Seven months later her brother's wife died of very acute phthisis.

Instances of industrial infection are more difficult to trace. A little painstaking inquiry will frequently bring such cases to light, but more frequently, the results are disappointing. In the majority of cases, the patient is doubtless subjected to several separate exposures to infection, all conspiring to bring about the resultant disease.

SOURCES of INFECTION.

Having established the fact that tuberculosis is a disease that may be communicated from one person to another we must next determine how the infection is trans-:mitted. Only by so doing can we get any nearer the heart of the problem of its prevention and cure. We have seen that, among some of the older writers, the clothes of consumptives/

consumptives, their feeding vessels, and their breath, were looked upon as the vehicles of spread. Still more recently much attention has been paid to the danger of food stuffs as carriers of infection, but, of probably greater importance than this, is the germ-laden sputum of the affected person. The sources of infection, then, fall naturally into two main groups:- (a) Infection from other human beings, and (b) Infection from Animal Food-Stuffs. In the case of infection from other human beings, the infection may be direct as from beads of expectoration being projected into another person's mouth or nostrils, or indirect, as from inhalation of dried expectoration.

There, therefore, fall to be considered:-

1. Infection by inhalation of dried expectoration.
2. Infection of inhalation of moist expectoration.
3. Infection by ingestion of tuberculous food material.
4. Infection by other means, e.g. through the skin.

A. INFECTION BY SPUTUM.

1. INHALATION of DRIED EXPECTORATION.

It has been estimated that a well advanced consumptive expectorates from 1½ to 4 million bacilli in twenty-four hours. Much of the sputum of careless individuals/

individuals becomes dried where it is deposited. When this occurs in areas under the influence of direct sun-:light, as in streets and open spaces, the bacilli are soon destroyed, whereas in dark and enclosed spaces such as rooms of houses and the like, infection may remain for as long as six weeks after the occupation of a con-:sumptive patient. The germs become mixed with the dust, which, even where the careful housewife does not exist, must on occasion be disturbed.

Again, the habit of spitting into handkerchiefs is a fruitful source. The handkerchief is stuffed into a pocket which in turn becomes contaminated, is withdrawn later, and generally shaken in the process, the germs thus, on each occasion being disseminated in the atmosphere, to the imminent danger of all such as be in the vicinity. The hands of the careless must also be considered a frequent harbourage for this tenaceous organism. Many experiments have been carried out to prove that infection may be, and frequently is, acquired by inhalation of dried sputum. The first such exper-:iments were done by Tappeiner, but those of Cornet are of the greatest importance, because they approximate, more nearly than those of other workers, to the natural conditions of life.

For his purpose Cornet scattered on the carpet

of/

of a room, dried phthisical sputum, placing guinea-pigs on stages at varying heights above the floor. The room was then swept in the ordinary way, and of the 48 animals used, 46 developed Tubercle. Koch carried out experiments with pure cultures, and found that infection might be acquired by inhalation.

2. INHALATION of MOIST DROPLETS of SPUTUM.

Experiments have likewise been performed to demonstrate infection from droplets of moist sputum, and it has been clearly established that the disease is readily communicated by this means. It remains very difficult to assess the relative importance of the two methods. In the droplets ordinarily propelled into the air in process of coughing, the number of bacilli,- as has been shown by Cornet, - is small as compared with the number in a tenacious plug of sputum which is likely to dry. Furthermore, the range of the spray infection is considerably less. Such droplets are seldom carried more than about a yard, except that very minute particles may be borne by currents of air for a greater distance. These small drops may remain suspended in the air for a considerable time, but not as a rule more than half-an-hour, and those few which remain so long are

seldom/

seldom loaded with many bacteria. The minute spray which generally proceeds from the mouth in speaking, as a rule does not carry infection. A very small number of bacilli lurk about the consumptive's mouth in the intervals between bouts of coughing.

If the bacilli were being discharged into the atmosphere in a free, unhampered condition, the danger of infection from both these sources would be very much greater than it is. A really dangerous number of bacilli exists in a ball of expectoration but this sputum is tough, heavy, and viscid, and the germs there are, as it were, in a prison. Even when the sputum dries the organisms are not liberated into the air.

This I have proved in the following manner:- A quantity of sputum was spread on a sterile glass slab under a sterile bell-jar and allowed to dry. The bell-jar was provided with a stoppered opening through which air was blown after a quantity of steam had been allowed to pass and condense on the inner side of the jar. No organisms could be found in the con-:densed water, nor could organisms be collected by means of drawing a platinum needle lightly over the hardened mass. They could, however, be found after rubbing the sputum vigorously with a glass rod, so as to reduce it to the state of a powder.

It/

It is no easy matter to pulverise dried phthisical sputum, and, on the whole, the more advanced the case the greater the difficulty. Sputum allowed to dry in a bottle or sputum flask can with great difficulty be removed from these. Thus, if sputum is projected onto a floor, ordinary methods of sweeping will not dislodge a great quantity of it nor a large number of organisms. Considerable friction, as with the boot, will first require to be used.

The only conclusions we appear legitimately entitled to draw in regard to these two methods of propagation of the disease are these:- that in domestic life, spray infection, i.e. infection from moist sputum, is likely to have the greater part, and in industrial life, infection from dried expectoration would probably prove the most important. Those who suffer from Tuberculosis, and work in factories or workshops, are not likely to carry a sputum-flask with them, or, if they do, are not as a rule in a position to make use of it. They expectorate on the floor or in any convenient resceptacle. The atmosphere of a public works is never a very good atmosphere, frequently the machinery is producing stromg and artificial air currents, and the amount of hither and thither movement on the part of workers is calculated to make dust of

some/

some, at least, of the dried sputum, which will become mingled with the ever-present particles that float in the atmosphere. Tuberculosis is always found to be specially prevalent in centres where the main industries are dust producing industries, as, for example, textile works.

On the other hand, in the home where relatives are nursing a case of Tuberculosis, their very kindness may prove their own undoing. A characteristic of the phthisis cough is that much effort is frequently needed before even a very little sputum may be dislodged. It is a trying sight to watch a relative racked for several minutes by an apparently purposeless cough, and so the sympathetic nurse supports him on the arm until the spasm is over. So is the havoc wrought! How often do we see a patient in the final stages, whose bed is ringed round by relatives not one of whom is beyond the range of spray propulsion. Too much has frequently been made of the possibility of acquiring infection from the breath of a patient, and it cannot too strongly be emphasised that the expired air of a tuberculous individual, is absolutely sterile.

It has elsewhere been stated that a relatively small number of organisms are to be found in the mouth of a patient between bouts of coughing. At the same time

germs/

germs are present, even though they may not be likely to be thrown into the atmosphere when the person speaks. It cannot be supposed that an individual may cough and expectorate, without some of the very viscid sputum remaining adherent to his lips and teeth. Thus, by kissing a sufferer or using drinking utensils after him, the unwary friend runs a grave risk of infection. The former ought to be entirely barred, while all utensils should be boiled, or, if this is not possible, steeped in boiling water containing a strong antiseptic, and it may here be recalled that five per cent carbolic acid will kill the Bacillus Tuberculosis in one minute.

3. INFECTION by INGESTION.

The problem of infection by ingestion of tuberculous food material is a particularly difficult one. Food stuffs derived from cattle and pigs are agreed to be the chief sources, but there here arises the question of the inter-relations of human and bovine types of the disease. It is in general accepted that infection by this means is infrequent relatively to that from dust and spray. That infective meat may cause the disease to appear in human beings is seen from the occurrence of local lesions in butchers, and it has been demonstrated that animals may be infected by feeding with tuberculous/

tuberculous meat. It has never been definitely established that, during the life of a single individual bacilli of the bovine type may be transformed into those of the human type, but both may produce disease in human beings, in whom lesions corresponding to both forms have been found. The bovine bacillus, at the same time, produces disease much more often, and much more readily in children than in adults, a fact which, for our pres-:ent purpose, is of paramount importance.

In these instances it is rarely that the infection will be acquired from meat, for meat is sel-:dom eaten uncooked, and heat destroys the organism. The usual medium for tramsference is infected milk, and in this case, the germs are generally derived from disease of the udder. Much of the tuberculosis of glands, bones, joints, and mesentery in young subjects, arises in this fashion. It must not, however, be assumed that in all such cases the cow's udder is the source of the infection. Milk may very readily be infected by the hands of those working with it, or from the atmosphere if it should be left standing when there is any possibility of organisms being borne in the air. Nevertheless, the most important thing is the disease of the udder. It has been variously estimated that from 2% to 10% of milch cows suffer from tuberculous disease of/

of the udder, and the milk from every such case is contaminated with organisms, sometimes in enormous numbers. An important feature of such udder disease is that it does not give rise to pain, or to tenderness in the process of milking, and may for a long period pass unnoticed, while the milk is heavily charged with its organismal products. The greatest quantity of milk is consumed at an age when the consumer is particularly receptive and dangerously defenceless, and when the ultimate result is but little dependent upon the type of bacillus ingested.

OTHER MODES OF INFECTION.

Other modes of infection include infection through the skin as by cuts and abrasions. As already stated, local lesions can be produced by this means, as in the case of butchers and pathological workers engaged in autopsies. As a public danger, however, the method can scarcely be regarded as of great importance. Speaking broadly, the danger of infection is in proportion to the number of bacilli gaining entrance to the body at one time, or over a prolonged period. Rarely in such instances can there by a long-continued reinoculation even with small doses of the virus. Experimenting upon myself I have failed to produce local tuberculides by a method similar to that used in vaccination. It seems to me that this/

this method of infection is a very precarious one, depending upon, (1) a particularly virulent organism, and (2) a peculiarly low resisting power.

The Royal Commission on Tuberculosis, in their second report issued in 1907 gave the results of experimental inoculation of Jersey calves, these being used because Jersey cattle are less liable to the disease than most others. The site of injection was the left side of the neck, and the effects were as follows:- At or near the site of injection a swelling developed, which either remained hard and firm, or had in its centre a cavity containing serous fluid. Soon the nearest lymph-gland began to be enlarged, and the temperature of the animal rose, this being accompanied by loss of flesh. In 20 to 50 days the animal died of general tuberculosis. It would appear, therefore, that general tuberculosis may be produced from local inoculation.

In these experiments, however, large numbers of virulent bacilli were being injected, whereas in accidental inoculation in human beings the number must, of necessity, be small. Lupus, a disease of the skin, is a local tuberculosis which has never been definitely proved to give rise to generalised disease. It has frequently been claimed that vaccination may be

responsible for transmitting the disease. Against this is the fact that calves used are carefully examined for tuberculosis, and the lymph rejected if any disease is detected. Sir Malcolm Morris says in this connection "I know of no evidence that general tuberculosis has ever been transmitted by vaccination. Graham Little has reported four cases observed by himself, and three by Colcott Fox, which seem to show that the transmission of lupus is at least a possible accident of vaccination. Fox, however, did not think that any conclusion of scientific value could be drawn from these cases. The vaccination sores might, he suggested, have been inoculated secondarily, or a previous tuberculous centre might have existed, and an embolus found its way to the scar." Stelwagon considers it as a remote possibility, qualifying this view by saying that, in such cases, the technique of the operator, or the virus is less likely to be at fault than the care and cleanliness of patient and friends.

In the case of children whose mucous membranes are very receptive, infection through them must be looked upon as a likely event, when the membranes of the mouth will be those most liable to be affected. The means in such cases may be kissing, drinking vessels, comforters etc. Persons who themselves would strenuously object

to/

to using any unwashed vessel after another person, do not appear to consider that there is anything objection-:able in forcing a young child to do so, while in some quarters the recognised practice seems to be for the mother, or woman in charge, always to moisten the com-:forter in her own mouth before transferring it to the baby's. At the same time, a baby is always the legitimate prey of those effusive and ultra-affectionate persons who cannot admire, amuse, or please without indulging in a moist and noisy osculation.

PORTALS of INFECTION.

In speaking of infection in tuberculosis, we have hitherto merely referred to the transference of bacilli from one person to another without particularis-:ing as to the point of entrance, or the method of dissemination thence, throughout the body. It has been shown that the most common mode of infection is by the inhalation of dried sputum, or of sprayed droplets. There are two primary gateways which the organisms have to pass before they reach really vital structures, namely the nostrils, and the mouth. In regard to the nostrils, it may be said that the resistance here met with is relatively great, and thus the bacilli seldom

are/

are able to establish a local foothold. The only local lesion met with in the nose is lupus, a very attenuated form of tuberculosis, but organisms certainly have been found in the nostrils of healthy persons, proving that they may enter the body by this route. St. Clair Thomson remarks that "the defences of the nose are so complete that acute tuberculosis hardly ever occurs there, and the lower down the infection of the air tract, the more virulent is the process." This does not appear to prove anything regarding the infection by inhalation. The mucous membrane of the nose is a specialised mucous membrane, which has got to face numerous irritations. Skin which is exposed to hard wear, e.g., the soles and palms, is specially resistant; so is mucous membrane which has particular work to do. Thus, a very large proportion of the germs that come to it, may pass it by without effect, to carry on this work elsewhere. To view the matter from a different standpoint, if the defen-:sive mechanism is particularly strong and destroys the organisms, only the robust and virulent bacilli will pass, and these will be the more able to create havoc in their new ground.

Nature always endeavours to provide against contingencies such as the entrance of inimical parasites/

parasites, and these bacilli find it no easy task to make their way to the really vulnerable organs. Having gained entrance via the mouth or the nose, and successfully negotiated the barriers there interposed they find still more defences to overcome. They enter, let us say, with dust. But nature has provided against the passage of dust to the lungs, and has made the channels for air inspiration, not straight, but possessed of many angles, which stop the greater part. At the same time the mucous membrane is very irritable, and the reflex actions of sneezing and coughing are readily set up. The whole respiratory tract, however, is possessed of cilia and a coat of mucus, and the former by their oscillations maintain a constant upward current of the latter. In this way direct infection to the lungs is reduced to a minimum, and the main hope of the bacteria is to establish a tempor-:ary hold of some part of the mucous membrane, and thence, by infectingglands, then the blood stream, to gain indirect access to the lung tissue.

There are some situations that especially favour the temporary arrest of the organisms. Thence, the principal channel of infection of the lung itself is the lymphatic one. The amount of superficial lymphoid tissue about the nose and throat is large, and

we/

we shall deal seriatim with the various groups.

A large number of children suffer from "Adenoids," - an enlargement of the collection of lymphoid tissue on the roof of the naso - pharynx, — the pharnygeal tonsil, or Tonsil of Luschka. St. Clair Thomson gives the proportion of children attend-:ing a special clinic, who are affected with hypertro-:phy of this tonsil, as 21·67%. The commonest time for this affection to become manifest is between the ages of 3 and 12 years. This overgrowth results in nasal stenosis, an unhealthy state of the nasopharynx, attended by a purulent discharge which does not have a free exit, and a marked lowering of the resisting power to disease in general. It has been estimated that the pulmonary capacity of affected children is reduced by one fifth. At the same time the attendant swelling of the mucous membrane, and the quantity of discharge present decrease the sensitiveness of the nose to external irritation. Although it is uncommon to detect tuberculosis of Luschka's tonsil on naked-eye examination, it has been shown by microscopic examina-:tion that tubercle bacilli are frequently present.

This tonsil forms a part of the collection of defensive lymphoid tissue grouped about the point of intersection of air and food passages, and termed the "Ring of Waldeyer." This ring consists of lymphoid tissue/

tissue, made up of lymphocytes uniformly distributed or collected into follicles, these follicles being in some instances collected into large groups called tonsils. The pharyngeal tonsil meets only such infection as gains entrance via the nose. The palatine tonsils, on the other hand, lodged as they are between the pillars of the fauces, stand in the way of infection from both nose and mouth. Many other infectious diseases appear to have their origin in the palatine tonsils and it seems reasonable to assume that tuberculosis may also frequent-:ly find them a profitable starting point. The question of tonsillar function still remains unsettled, some regarding these glands as rudimentary structures both useless and dangerous, some looking upon them as powerful defenders of the respiratory and digestive tracts. Be that as it may, although they seldom show naked-eye evidence of tubercle, bacilli are very frequet :ly found in them. Thomson found histological evidence of tuberculosis in 6·5% of tonsils removed, while a very large number of cases dying of phthisis show infection of the tonsil. Whether this infection is primary or secondary cannot of course be determined, but the amount of tuberculosis in tonsils removed for disease is probably no good guide because those so affected are generally small and atrophic, while those removed are, as/

as a rule, large and overgrown.

The lingual tonsil, which completes the large masses constituting Waldeyer's Ring, seldom seems to be the site of primary tuberculosis, but another mass, sometimes honoured by the separate name of "Tubal Tonsil" lying at the posterior lip of the eustachian orifice, probably plays a big part in those cases where tuberculosis appears to be a sequela of "discharging ears."

Even before the tonsils are reached, a source of considerable danger exists in the double row of grinding organs which often prove in the getting, the having, and the losing, a source of great annoyance, - the teeth. The mass of the population seem now to have realised the fact that carious teeth in the adult are dangerous, but few indeed are the parents who can be persuaded that in children, decayed teeth are anything but a physiological necessity. In the child's mouth they are allowed to remain until they slacken and drop out; while the gum-boil is allowed to come and go, unchecked, unhelped. It is only when the submaxillary and cervical glands begin to swell and soften, that the doctor is consulted. The inside of those teeth contains much dead matter that forms a suitable nidus for the growth of the bacillus tuberculosis/

tuberculosis, both in children and adults, and it has been bacteriologically proved that these organisms do there exist, more especially in the young.

Speaking generally, the Larynx may be said to be of great importance in tuberculosis. It has been stated that tuberculous disease of the larynx exists in about 10% of early cases of the pulmonary form of the disease, and in as much as 72% of late cases. In spite of this great frequency of occurrence as a com-:plication, it is found to be a rare site for primary infection, so rare indeed, as to be regarded by laryng-:ologists as a very remote possibility. Lupus does, though rarely, occur as a primary disease. Of equal infrequency is primary infection of the trachea and bronchi.

Tuberculosis not consequent upon disease of the lungs has on rare occasions been found in the pharynx, affecting the fauces, soft and hard palate, base of tongue, and epiglottis. Lupus also may occur, affecting principally the uvula and anterior pillars of the fauces. The real significance of lupus in its relation to lethal tuberculosis is not quite clear, but there are found in the upper air passages and pharynx, nodules that might reasonably be looked upon as inter-:mediate stages, and which are called by the name "lupoid tubercle."

In/

In surveying in general the upper air passages as a portal of entrance for tuberculous infection, it must be recalled that minor diseased states of this area are of very common occurrence. Hypertrophic Rhinitis, ~~Athropic~~ Atrophic Rhinitis, Sinusitis, enlarged tonsils and adenoids with their attendant chronic catarrh and consequent devitalisation of the mucous membrane, both by their local effects, and by the resulting lowering of the general condition, render the individual much more liable to a ready acquisition of the disease.

Passing now to a consideration of infection commencing lower in the respiratory tract, we find great diversity of opinion. Some observers believe that direct infection of lung tissue by inhalation is a very common event, while others consider it to be a very remote possibility. Proof that dust may enter the lungs and become deposited in the connective tissue is not far to seek, for, in the pneumonokonioses we have a clear example. Numerous experiments, e.g. by Zenker and Knauff, have been carried out on animals to demonstrate that particles may find their way by inhalation to the lungs. Other workers, however, find inspired air sterile by the time it reaches the bronchi, e.g. St. Clair Thomson. The balance of evidence is in favour/

favour of the possibility of germ-laden dust occasion-:ally reaching the lung direct.

Short of such direct infection, there are other means of involving the lung tissue. The bronchial glands no doubt play an important part. The organisms possibly enter by way of the lymphoid tissue of the pharynx or teeth, and from there are carried by the lymph stream, first to the cervical glands, thence to the bronchial and mediastinal glands, and from there by way of the peribronchial lymphatics in many cases, to the lung tissue. The first part of the lung to be involved in such cases, is the root. This mode of infection probably is of considerable importance in children, for in them the adenoid tissue of Waldeyer's Ring is often hypertrophied, always receptive, and the roots of the lungs are frequently the first parts attacked.

Tubercle bacilli are not always borne to their destination by the lymphatic stream. It is not altogether an infrequent occurrence for a caseating gland to break down the wall of a vein. In such cases infection is carried by the blood to the heart, and thence to the lung, where a small infarct is formed. Here is dead tissue, and an excellent opportunity for the organisms to multiply.

It/

It is not, however, generally accepted that infection by inhalation is the prime means of acquiring tuberculosis. Many workers still adhere to the view that ingestion plays a much greater part. A consider-:able amount of work has been done in recent years, in an endeavour to answer this question, but the results are still inconclusive. It has not been shown that infection can ever occur through the wall of the stom-:ach, and tuberculosis of that organ is of extreme rarity, while primary lesions in this situation are unknown, although ulceration in advanced pulmonary tuberculosis has been described, especially in children. At the same time, experiments dealing with the effect of gastric juice on tubercle bacilli have shown that the secretion is not fatal to them, at least within the normal period of stomach digestion. Falk, Wesener, Wurtz, Strauss, Frank, Fischer etc. have all made authoritive pronouncements in this connection, both artificial and natural juice being used on tuberculous material, and on pure cultures.

The frequency of intestinal tuberculosis seems to indicate that the organisms may pass right through the stomach with their virulence unaffected. Lesions of the intestine occur in 30% to 90% of pulmon-:ary cases, the figure given by various observers being widely/

widely different. In a large proportion of such cases, the intestinal infection is doubtless secondary to a pulmonary lesion, but this does not, of course, preclude the possibility of the lung being attacked via the intestine in the first instance. Primary disease of the intestine certainly does occur, especially in children. The part more usually attacked is the lower part of the ilium, the Peyer's patches and solitary glands becoming enlarged, either uniformly or in scattered, irregular areas, while foci appear also in other parts of the mucous and submucous coats.

The reports of different workers on the frequency of primary infection of the intestine are very contradictory. The figures from post-mortem records are most confusing. Thus, Still finds the channel of infection to be through the alimentary canal in 29·1% of his series of autopsies, (269); Carr gives 16·7% out of 120 cases, Shennan 28·9% out of 355 cases, amd Guthrie 24·7 of 77 cases. Still further states that in his experience, while the relative frequency of intestinal infection to lung infection in children under five years was one to three, in children over five years it was one to one.

German workers give very much lower figures than these, and many look upon primary intestinal

infection/

infection as a rare event. The same applies to the statistics of Holt, Northrup, and others from America. Other authorities in Germany, however, notably Wagener, Kof, Heller, Hueppe, get results much more nearly approaching those of the English workers.

Although the majority of the students of tuberculosis consider infection through the intestinal tract less frequent than infection by way of the respiratory system, placing the proportion of cases by the former method at about one third of the whole, Calmette's view was that by far the greater number derived infection through the intestine, and Whitla has recently re-expounded this opinion, with a mass of exper-:imental work in support thereof. Thus, Calmette, experimenting on young goats found that, when they were fed with milk that was tuberculous, they all developed intestinal and mesenteric disease. Adult goats, fed through an oesophageal tube with tuberculous material, developed pulmonary tuberculosis. Whitla, by feeding with pigmented particles, was able to trace the route taken, and found that much of it at least reached the lungs by way of the mesenteric glands, thoracic duct and venous blood.

The point of entry of the bacilli in the intestine is not always marked by a local lesion, and it appears/

appears that on occasion the organisms may penetrate it without injury, and reach the mesenteric glands. On the other hand, where the channel of infection has been definitely the bowel, the mesenteric glands do not always show evidence of the disease. It is almost a certainty nevertheless, that mesenteric involvement occurs, and that the spread from these to the lungs, if any, is by the route detailed. At the same time, it may sometimes occur that a direct extension through chains of lymphatic glands takes place, the mesenteric infecting the retroperitoneal which carry the disease through the diaphragm to the posterior mediastinae and bronchial glands.

Two other methods of entry are worthy of notice by virtue of their great importance in children. Of these, the first is by way of the ear. Otitis media is a common disease in childhood. As a sequel to the acute exanthemata, measles and scarlet fever, it occurs with considerable frequency, but, quite apart from these, it is a common result of enlarged tonsils, adenoids, and hypertrophic rhinitis. Whatever is the predisposing factor, it is generally brought about by extension of a post-nasal catarrh along the eustachian tube to the middle meatus. When the tympanum becomes ruptured, and, as is frequently the case, fails to close, there is a free opening to the external ear, and consequently/

consequently to the air. In consequence, as is usual in the case of pyogenic infections, the nearest glands become enlarged and tender. The amount of tuberculous infection that enters by this route may be very small, but a suitable soil is prepared for the reception and growth of the organisms, and tuberculous cervical adenitis, with all its dangers to bronchial glands and lungs, is very readily produced.

Reference has here been made to the exanthemata, and it seems a convenient place to mention the great frequency with which tuberculosis follows measles in children, and the same applies to whooping cough. Again, the catarrhal nature of the diseases, with attendant enlargement of lymphatic glands, is probably the important feature, enlargement of mediastinal glands making easy the entrance of the graver disease.

The other important factor, especially in children, is the presence in the head or elsewhere, of parasites. No matter how carefully the child may be looked after, there is little doubt that most children at some time acquire the pediculus capitis. In those who are neglected, whether from habits of uncleanness or from a mistaken idea that the child cannot be so attacked these insects multiply with amazing rapidity, and give rise/

rise to much irritation. Naturally, the child scratches, and soon a more or less severe impetigo contagiosa is set up. Again the result is swelling of adjacent glands, and in a great many cases, this does not long precede the development of a "cold abscess." This may be an example of inoculation through the skin, or the pyogenic infection of the glands may simply cause to light up a buried mass of bacilli such as has already been mentioned.

In a lesser degree the same may be said of scabies. At any rate, I have seen two cases of tuberculous glands, one in the groin and on in the axilla, where severe scabies existed on the correspond-:ing limb.

One other possible source of infection which does not seem to receive sufficient attention, is the eyes. Phlyctenular opthalmia is by no means rare, and is generally accepted as being a tuberculous mani-:festation. Twenty-five cases examined and treated by me gave a positive reaction to Von Pirquet's Tuberculin Test, and all, save two, improved under Tuberculin Treatment. In five of these cases cervical adenitis either was present, or developed, in none of which could it be found from the history that the adenitis existed before the eye condition. One case had/

had a slight cough, and tubercle bacilli were found in the sputum.

As against this evidence is the fact that organisms have not been isolated from Plyctens and that inoculation experiments have proved negative. Among those who favour the view of the tuberculous origin of phlyctenular ophthalmia it is generally regarded as being a product, not of the organisms themselves but of the toxins, and in this connection it is to be borne in mind that dead bacilli, and therefore the bacillary toxins, can produce tubercle-like nodules. Despite this it is taking too much for granted to assume that the organisms do not exist somewhere very near the eye.

VARIETIES of the BACILLUS.

It has been found that organisms having many features in common with the bacillus tuberculosis whose biology we considered, exist in four distinct groups of animals:- human beings, cattle, fish, and birds. In warm-blooded animals the bacillus of fish, which, in staining reactions, and microscopical characteristics appears very similar to the human type appears to have no effect. It grows well at room temperature. But acclimatisation has failed to produce good growth at blood/

blood-heat, or to cause it to multiply in the bodies of warm-blooded animals. It may, therefore, be set aside as of no importance.

No statement so definite can be made in regard to the "Avian bacillus." Birds are subject to a disease presenting features similar to the tuberculous lesions of man and cattle, and from the nodules a bacillus, morphologically comparable, and in staining reactions corresponding to the human tubercle bacillus is isolated. The results of experimental inoculation and attempts at cultivation, however, mark it off as belonging to a separate genus. Nocard claimed that by acclimatisation the organism of human tuberculosis could be made to assume the characters of the avian bacillus, but the Royal Commission did not get similar results from the same type of experiments.

Up till 1901, it was generally considered that all tuberculosis of mammals was due to one and the same organism, but in that year Koch stated his conclusion that the bacillus of bovine tubercle was distinct from that of the human disease. This conclusion was the result of observations tending to show that the germ derived from cattle produced more severe lesions in guinea-pigs, rabbits etc. than the human organism, and that the latter in cattle produced at most only a local

focus/

focus without dissemination. It has since been proved that the cultural characteristics of the two organisms are essentially dissimilar. The bovine bacilli from cultures are shorter and thicker, and grow less luxuriant-:ly on certain media than the human. Thus, on Dorset's egg medium, the human type has an abundant dry and wrinkl-:ed growth of yellowish or pinkish tint, while on the other hand, the growth produced by the bovine bacillus is thin, white, smooth and moist. Dorset's egg medium is made as follows:- The contents of four fresh eggs are beaten up, 25 c.c. of water is added, and the whole, when thoroughly mixed, is filtered through muslin. The mixture having been placed in tubes, these are placed in a sloping position and heated for four hours at 70 °C. The mixture, covered with 0·8% Sodium Chloride is steril-:ised and is then ready for use, a drop of distilled water being added before inoculation. The addition of glycerin favours the growth of the human bacillus while it may even inhibit the growth of the bovine type.

The Royal Commission on Tuberculosis has been already referred to. The results of exhaustive investigations were embodied in the 1907 report, which showed that the bovine type might occur in lesions in human beings, and that in fact it was present in 50% of cases of abdominal tuberculosis in children, while it has

more/

more lately been shown that in children under 10 years of age 70% of glandular tuberculosis is caused by the bovine germ. On the other hand, organisms belonging to the bovine strain have been found in less than one per cent of cases of pulmonary tuberculosis.

A summary of results of experimental work is as follows:- (1) The bovine type of bacillus may, in addition to the human type, produce disease in man; (2) The bovine type is found more commonly in children than in adults , in whom it is rare; (3) Where the bovine type is present, infection is almost always by ingestion, and affects only glands, or abdomen, rarely the lungs; (4) It is not proved that organisms of one type can be so altered as to assume, in the body of the host or elsewhere, the full characters of the other type.

It is seen, from all that has been said that tuberculosis is a pandemic disease, leaving very little of the world, very few species of its fauna, immune from its attack. Unlike many infective diseases, it has no seasonal incidence, taking a bigger toll at certain periods of the year only because those times favour overcrowding, warmth, and the intimate association of persons. It is no respecter of age, or sex or race. In regard to race, the terrible results on certain peoples were witnessed during the great war, when men came to Europe from races, whose natural habitat and climate/

climate were less suitable for the multiplication of the germ than ours. In such cases the bacillus having virgin soil to work on, wrought terrible havoc.

Thus, although from the foregoing it seems a marvel that anyone could escape, it is obvious that there are modifications, and conditions which would account for the difference between the 90% and 97% given as the number who acquire the infection during their lives and the much smaller per-centage who died of the disease, - about 0·1% according to statistics, - or who require medical attention,-a rather indefinite figure. In the succeeding pages, these modifying factors fall to be considered.

MODIFYING FACTORS.

It would appear that some persons are attacked much more readily than others, and that, once they are infected, the disease in certain individuals is much more virulent, and more rapidly fatal. There are many possible explanations for this fact, one or more being generally present and determining the onset and course of the infection.

In the first place, the influence of heredity has to be taken into account. When the importance of infection began to be realised, belief in heredity as a predisposing/

predisposing factor sank for sometime, into the back-:ground. Recently, however, it has again come to the front, with new adherents and new proofs. Something has already been said in this connection, and nothing need here be added save a summary of the conclusions, viz:- (1) Direct germ inheritance is very rare, if it ever occurs. It is proved to occur in cattle and has not been disproved in the case of human beings. (2) There is little doubt that some families are more liable to acquire this disease than others, so that there does appear to be an "inherited predisposition." The argu-:ment of Sir James Kingston Fowler, that this is unlikely because individuals from a community where tuberculosis is almost unknown are especially prone to be attacked when exposed to infection, seems to me to annul itself, for, even those born with a predisposition to the disease, have opportunities of acquiring a certain amount of immunity to counteract the inherent weakness, while those who constitute a virgin soil, have no such opportunity. (3) Those families which have no history of tuberculosis, but are composed of weakly, constantly anaemic and ailing individuals, are also readily preyed upon by this germ, I.e. those who have a congenital predisposition to disease in general. (4) The weakness may not be so much a special liability to acquire the disease but an inher-:ent inability to fight it by production of antibodies

and/

Plan of the Royal Burgh

and consequent immunity.

Infection having been proved to have an important role, and heredity being established as a possible preparer of the soil in some instances, we have yet to consider what other factors play a part in making tuberculosis the most widespread of the diseases flesh is heir to. There can be no question that environment is of paramount importance, Even in theory this would seem only natural. Fresh air and sunlight are proven enemies of the bacillus, so that what would be needed would be over-crowding, darkness, and damp, with an absence of free ventilation.

Experiments on animals kept under poor hygienic conditions have proved that in such circumstances the disease is readily developed. Furthermore, experience shows that it is much more prevalent in places where poverty and insanitary conditions are found. An analysis of 195 consecutive cases notified in Arbroath district shows some interesting facts. In these 195 cases, 73 streets were represented. 35 streets had one case each, leaving the other 160 cases to be divided among 38 streets. This is much more significant when it is pointed out that the streets are short, and in many cases group to form squares, or continuations as is shown on the accompanying map. The streets/

streets represented by these are all of working-class houses, many consisting of one storey and attics, the latter being let to separate tenants. In most cases the windows are small, while in a large proportion the floors on the ground floor are of stone. In a certain number water is not conducted into the houses, but is carried by the occupants from a pump in the back court. Sinks are not provided, and a common lavatory serves a group of houses. These being the conditions,- together with sleeping accommodation in the form of "box" or "concealed" beds, that is to say, beds built into recesses in the walls,- it is probably natural to look for a fairly heavy tuberculosis incidence, but at the same time, the people themselves do not make the best of their opportunities. In such houses, consist-:ing for the most part, of a miximum of two apartments, large families are all too frequently grouped together. For this the occupants cannot be held to blame, for no alternative is available for them. Yet there seems to exist a natural repugnance to fresh air which is looked upon as the cause of the disease by producing "draughts." In a tour of inspection, I counted on one occasion, in a group of streets where tuberculosis was relatively common, out of 1000 windows facing the street, 156 which were open! Such a state of affairs, of course, is/

is full of the gravest dangers.

Habits of uncleankiness likewise favour the development of tuberculosis. Dirtiness of the person, lack of attention to the mouth, slovenly customs as regards disposal of sputum etc., carelessness in storage of food, especially milk and those articles of diet which are to be eaten cold, all conspire to make the entrance of virulent organisms easy. Recently I went to inspect the house of a phthisical patient, a woman. She lay in an unclean box bed, with a clay pipe beside her. From the edge of the bed, a semicircle of about twelve inches radius, on the floor, was covered with sputum. Her husband sat on a low stool shelling mussels for bait, and likewise he smoked a clay pipe and spat on the floor, now on one side now on the other. A friend sat talk-:ing to him, and did likewise. On the dirty table stood the unwashed dishes and uneaten scraps from several meals. The two windows which the house boasted, were nailed up in the closed position while from floor to ceiling, which was only seven feet above the former, the atmosphere was one blue blur of heavy, pungent, tobacco-smoke.

Such evidence of dirty habits as the possession of parasites in hair or skin, have already been referred to. The possible influence of the use of common lavatories, and the carriage and storing - generally in an/

an outside lobby - of water may be inferred from the fact that in four instances in the 195 cases above mentioned more than one case occurred in the same tenement but in different houses, in one building as many as four cases being found.

Age plays a very important part also, in determining the incidence of the infection. In old age this disease is not of very common occurrence, not does it often arise in infants. From the second year to the twelfth there is a steady increase, after which a fall in incidence takes place till about the twentieth year. The next twenty years of life show the greatest incidence, and the greatest mortality. The explanation of this is that in children tuberculous meningitis and tabes mesenterica are the most common causes of death from tuberculosis, and that these forms seldom occur outside childhood, while in later life phthisis, which much less frequently affects children, is the more usual cause of death. The greater susceptibility of children to infection through certain channels, as already discussed, accounts for the special forms of disease in them.

Nothing very definite can be said of the influence of sex on the incidence of tuberculosis. Death-rate figures are not very conclusive, and vary greatly/

greatly in different localities. Physiological strains in female life, however, are much greater than in male life, and at the great epochs, puberty and the climacteric, as well as during pregnancy, the influences at work within appear to lower the resist-:ance power to hurtful influences without. Thus, at puberty and the climacteric, latent foci seem very readily to light up into active and rapidly progress-:ive lesions. In pregnancy, on the other hand, arrest of the disease sometimes appears to occur.

At the present time I have under observa-:tion four cases in which pregnancy supervened on chronic pulmonary disease. In all four cases a marked improvement was noted during the course of the pregnancy, and in two the disease had apparently undergone arrest, without alteration of treatment. It is further to be noted, that phthisis does not appear to cause a lessening of fertility, but on the other hand, tuberculous women often seem to be especially prolific.

Malnutrition and over-exertion are powerful agencies. When tuberculosis is present, the success of treatment depends very largely upon maintaining the physique as far as possible with nourishing and easily assimilated food. How much more then, must

freedom/

freedom from infection depend upon a proper maintenance of the balance of intake and output. Conditions of fatigue, because they reduce the resisting power in general, favour the entrance of the bacillus, and the same may be said of exposure to cold and wet. In close relationship with this is the subject of clothing. Over clothing is just as harmful as clothing too lightly. A very definite distinction has to be drawn between warmth, and weight.

Trauma may be looked upon as a predisposing cause in some instances. Injuries to bones and joints are likely to cause a renewal of activity of any latent focus that may be present. Certainly a history of injury is frequently obtained in cases of joint disease, and it is quite conceivable that, if a small collection of encapsulated organisms should happen to lie in a joint that sustained sudden and violent damage, as from a fall, a blow or a sprain, the disturbance might result in their assuming an added virulence, and attacking the synovial membranes temporarily devitalised by traumatic inflammation. In the case of the lungs, operation wounds have been found to be followed by the development of phthisis, while in the War, gun-shot wounds of the chest frequently, after a varying interval, have had as a sequel pulmonary tuberculosis.

Certain diseases are well known progenitors of tuberculous/

tuberculous lesions. Measles and Whooping Cough in children, have elsewhere been considered. Common "colds" are found with great frequency in the histories of patients, but many things are called "colds", - and the profession is not always guiltless, - which might have a more definite name. There can be no doubt, however, that Influenza is of great importance. This disease is most debilitating, and, in addition, the treatment in most instances is essentially lowering. This in itself would be enough to lay the patient open to the dangers of a graver infection, In many instances what the patient acquires in the first instance, is a mixed infection. Bronchitis and Pneumonia, of course, by their weakening of the tissues of the lungs and air passages, besides the general effect upon the body, must be looked on as predisposing causes. Pleurisy is frequently from the start a tuberculous manifestation, but even streptococcal and pneumonoccal infections undoubtedly lead sometimes to phthisis. What doctors of a generation ago referred to as "pneumonia with delayed resolution", - recognised to-day as empyema, - especially prevalent in young subjects, is all too frequently, nothing less than the commencement of a rapidly progressive consolidation of tuberculous origin, the pus in many instances containing, in addition to pneumococci/

pneumococci, staphylococci, and streptococci, the bacillus tuberculosis. Even when the last named cannot be isolated in the pus, it is my opinion that the case should from the start, be treated as if it were there.

Typhoid fever, especially in cases of infection by the bowel, must play a certain part, while diabetes has been proved, especially in the young, to be a frequent predisposing cause. Among the Insane, tuberculosis has been found to be a frequent cause of death, but the predisposing factor is not so much the mental disease, as the results of certain symptoms, as refusal to take food, the frequent, though not always intentional infliction of injury, together with the confinement either symptomatic or enforced. Thus it falls under the heading of malnutrition.

The numerous catarrhs of stomach, bowel, and respiratory passages, very often are given in the histories as predisposing causes or antecedent incid-:ents, but are much more frequently early manifestations of the disease, and as such, fall to be considered elsewhere. One other factor of great importance is alcohol. By some, alcohol, is looked upon as, to some extent, a preventive of disease. More likely it is the determining cause in the production of unhealthy states/

states. In strictly moderate doses, there is no doubt, it acts not only as a diffusible stimulant, but also as a food. In larger doses it is a poison. Indulged in, to an intoxicating extent, it lays the user open to more frequent infection, while it makes him more careless in his habits, and, by its narcotic effects, so dulls his preceptions that the first symptoms pass almost unnoticed until irreparable damage has already been done.

PREVENTIVE MEASURES.

The magnitude of the danger from tuberculosis makes it imperative that we should take very strong and active measures, not so much to combat the evil once disease has started, but to prevent the disease by placing those most liable to be infected out of reach of harm.

A great deal depends upon the Authorities having control of various areas, but much may be done by the people themselves. To serve such an end, our part must be to educate the masses. The repugnance to fresh air, the fear of draughts, and all habits of life tending to aid the development of disease must be rooted out. Such teaching would require to be started in early life. Children do not leave school until/

until they are fourteen years of age, and this fact allows of plenty of time being devoted to an elementary teaching of laws of hygiene. All Education Authorit-:ies should be strongly urged to insist on such a course of instruction being included in every school curriculum. This teaching should include the culti-:vation of habits of cleanliness and love of fresh air, together with an avoidance of dust and dirt in the environment. At the same time, the proper handling of food-stuffs should receive attention, the cleansing of dishes, utensils, and places for storage being carefully considered. Of equal importance with these must be noted correct methods of breathing. All children should be instructed in proper nasal breathing both during rest and in exercise, while physical drill ought to be given a much greater place in school work than it now has.

Once the child has left the schoolroom the time is past for attempting such training, and much then depends upon Local Authorities. That there are still, in all our towns, houses that are unfit for human habitation is an undisputed fact. This must be put right. Every endeavour ought to be made to prevent overcrowding in houses, while the actual structural features of houses should be such as to make cleanliness

more/

more easily maintained. It is of little use teaching children the theory of hygiene, if the home conditions are such that the new ideas cannot be carried out.

The whole problem of housing, nutrition, poverty and alcohol is so large and so complex, that, as this is not a treatise of sociology, it cannot be fully considered. The relative allurements of the home and the public house must have a great effect upon the state of nutrition. If the house is comfortable, the public house in most cases, would be the less desirable, and all members of the household would benefit accordingly. Much is being done in the way of providing counter-attraction, as Work-Clubs etc. but much remains still to do.

Everything that helps to prevent malnutrition, over-indulgence in alcohol, overcrowding, improper feeding, over-fatigue and dirt, and leads towards a cleaner brighter life, will tend to decrease in the incidence and mortality of tuberculosis.

Among the indirect measures that might influence the control of tuberculosis, must be consider-:ed the Sanatorium Benefit of the National Insurance Act. This act provided facilities for insured persons receiving treatment in sanatoria, without unnecessary hardship. Had the scheme been carried out in accord-:ance/

:ance with the terms of the Act, it might have borne useful fruit, but in 1921 the whole thing was dropped, the general schemes of local authorities being regard-:ed as sufficient.

More direct methods against infection have also to be considered. The milk supplied to chil-:dren should always be sterilised by boiling or pasteurisation. Expectoration should always be dealt with, with scrupulous care, while unhealthy tonsils, adenoids, enlarged turbinates etc. ought always to receive due attention. Such measures concern the individual, but the various Authorities with powers require to use their powers to the utmost. In this way, supervision of milk supply, inspection of houses, shops, workshops and factories, require to be carefully and regularly attended to. Public convey-:ances, places of assembly, lodging-houses, also need attention.

By such means the danger of infection may be materially reduced, but it cannot hope to be eliminat-:ed. There will always be the cases occurring, though not perhaps in so great numbers. Every such case is a positive danger to his neighbours, and the danger increases with the advance of the disease. Furthermore, the chances of recovery of the individual

are/

are practically limited to the early stages. Small caseations may be shut in and become fibrotic, large cavities cannot close. It is therefore, of the first importance that tuberculosis should be recognised early. By such early diagnosis, not only one life may be saved, but the infection of two or three other persons may be obviated. Every day's delay may mean a year or two off someone's life, and suffering for other members of the community.

Once diagnosed, the case must, by law, be notified to the Public Health Authority. All depends upon very early notification, for by this are inspect-:ion of premises and examination of contacts made possible. It is little more than ten years since notification of tuberculosis became general, and many cases probably still remain unnotified. As time goes on and diagnosis becomes more exact, this number will, no doubt, diminish, and an elaborate method of investigation and prevention will enable us to reduce the risks of infection very materially. There can be no doubt that harmonious co-operation between Practitioners in Private Practices, and the Public Health Authorities, will ultimately lead to a considerable fall in the mortality from this disease. At the same time it is important that the patient, and the/

the patient's friends should be at once informed of the actual state of affairs, and instructed as to procedure. These instructions ought to embrace not only the proper conduct of the patient as regards himself, but also his behaviour as regards his neighbours. The rules to be laid down for the sake of the patient are as follows:-

(1) Every endeavour should be made to prevent further infection.

(2) Abundance of fresh air should be supplied.

(3) Nutrition should be improved by careful and generous diet.

(4) A sufficiency of rest should be taken.

As regards (1) it is to be remembered that the patient is not only in danger of acquiring fresh infection from outside, but he may reinfect himself. Consequently every precaution has to be takem in the disinfection of his quarters. Further, sputum should on no account be swallowed. This is most important matter, since it has been seen that lesions in other parts of the body may readily be produced by this means. All sputum should be very carefully disposed of in the manner to be described later.

Fresh-air means much. Not only does it imply an atmosphere as free as possible from the expired air of other lungs, but also an atmosphere as free/

free from dust and from moisture as can be found. It is in this particular that sanatoria treatment scores over other forms, and where the sanatorium placed at a high altitude has a special advantage. Dust not only aids the spread of the disease but hampers its treatment also.

It has already been shown that malnutrition is a great friend of the tubercle bacillus in preparing a suitable soil for its establishment, and much more does it aid the germ, once settled down, to pursue its devastating work unchecked. If the body is to make a successful fight against the infection, it must be supplied with an abundance of easily assimilated and highly nourishing food.

In close relation to this is the question of fatigue. Rest in all diseases is a great healer, and even more so in tuberculosis than in many. Whether it be glands, or joints or lungs that have the infect-:ion, absolute rest in the early stages is of first importance. As time goes on, a modicum of carefully regulated exercise should be enjoyed, but this must at no time, be sufficient to cause a suspicion of fatigue. The rest, however, must be taken in a room with free access to fresh air. The patient ought to occupy a room by himself with windows fully opened top and bottom/

bottom.

The patient is a danger to his neighbours, chiefly by virtue of his expectoration. Indoors, this should be received in a cloth or paper to be burned immediately, or in a vessel containing disinfectant, which can be washed with boiling water. Outside, a bottle or flask should be used and this likewise must afterwards be washed out with boiling water. Dusting and sweeping of rooms is to be avoided, and wet cleansing substituted wherever possible. This can be combined with the use, either in the washing water or as a spray, of disinfectant fluids.

After notification by the general practitioner in charge of the case, the local authority has its duties to perform in regard to each case. There can be no question that the majority of cases respond better to institutional treatment. In addition, by such means are patients removed from their friends, and thus cease to be a danger to them. Two classes of sanatorium treatment exist, viz: (a) for early cases, where there is a hope of cure; (b) for late cases, where there is no hope of cure, but prolongation of life may be expected, and the danger to others is eliminated. Sanatorium treatment is simply an elaboration of "open-air treatment." This had been practised for many years before the idea of adapting it to institutional segregation was formulated. To

Brehmer/

Brehmer of Görbersdorf and Walther of Nordach belongs the credit of establishing the first Sanatoria. The former opened his hospital in 1859, with the object of providing;

(1) An open-air life,

(2) Freedom from debilitating influence,

(3) Exercise on methodical lines,

(4) Suitable and abundant food,

(5) Systematic medical supervision.

The methods of Walther were less severe. He chose his site with great care in a valley 1400 ft. above the sea, on a subsoil that readily absorbs moisture, and the hospital was built as as to ensure, as far as possible, freedom from dust. Dettweiler of Falkenstein carried the work still farther, going more upon the lines of Brehmer. Notable among the pre-sanatorium users of the open-air method, stands the name of George Bodington of Sutton Coldfield, Warwick-:shire, who, during the first half of last century, seriously and systematically carried out the open-air treatment. Others worthy of mention are Andrew Stewart, and William Buchan, both of whom, more than fifty years before, advocated similar methods.

No hard and fast rule can be laid down for sanatorium construction. Site, in the first place, is of great importance, and must be considered from the following/

following points of view:-

(1) The climate should be neither too cold in winter nor too hot in summer, and should enjoy a fair rainfall, for the purpose of washing the air and keeping it free from dust.

(2) The subsoil should be of such a nature that moisture readily percolates, leaving a dry surface. Probably the most satisfactory is sandstone.

(3) A situation giving maximum clear air, but sheltered from severe wind is undoubtedly best. This can be obtained as at Nordach by building in a valley, high above sea-level.

(4) While sufficient shelter of the building is advisable, and while sheltered walks round about are essential, abundance of direct sunlight must be attainable.

(5) The "pavilion" system of buildings is certainly to be preferred, each pavilion being separated from the others. The question of whether separate rooms, or wards, are better for accommodation of patients is less easily settled. While separate rooms certainly minimise risk of infection, wards for ten or a dozen patients, provided sufficient cubic space per bed is allowed, permit of a more thorough "through ventilation", and, as a rule, of more light.

(6) As regards internal arrangements it suffices to say/

say that furniture should be of the simplest, hangings reduced to a minimum, and the whole - floor, ceilings, walls, furniture, - able to be washed. A well finish-:ed parquet floor is the best, while a washable dis-:temper has advantages over paint.

If sanatorium treatment is to be successful, it must be carried out on very systematic lines. In the early stages, especially when the case is attended with fever, absolute rest is advisable. All exercise, even talking, is to be forbidden. When the temper-:ature is no longer elevated and the cough and expect-:oration are lessened, the patient may be allowed out of bed, and a little exercise may be enjoyed. All such exercise requires to be most carefully regulated. At first it consists merely of walking a measured dis-:tance, this distance being tentatively increased day by day, while a slow steady pace is always maintained. As time goes on, provided the patient is gaining in weight and strength and no rise of temperature takes place, other forms of exercise are added. To begin with light gardening or the carrying of small loads may be given, the type of work being gradually made harder, and the loads heavier. Throughout the treatment, meals are to be taken at regular times with long intervals, e.g. five hours between, and a long rest before each. Early retiral at night must always be/

be the rule.

Such methods of graduated exercise have had most excellent results. By the time a patient is ready to be discharged he will be doing what practically amounts to a full day's work. Thus, the sufferer will have learned to live an outdoor life, regulated and well ordered in all respects, and the sensible per-:son will, upon discharge, continue in the same way.

The patient upon leaving should be carefully advised regarding his future mode of living. The great importance of occupying a separate room, both the door and window of which are open, has first to become planted in his mind. Avoidance of dust and smoke comes next, coupled with the advisability of wet clean-:ing in preference to dry dusting and sweeping. Advice as to coughing, and the use of the sputum bottle at all times is essential, and finally he must be en-:joined to maintain a good state of nourishment, by the taking of good food, at regular times, with plenty of milk, butter, and eggs, the use of Cod Liver Oil, and avoidance of alcohol.

The after-case is a comparatively simple matter in those of good circumstances, but the majority of sufferers from this disease belong to the less happily placed. In them a great difficulty arises in/

in the necessity for undertaking some form of employ-:ment. For a patient who leaves the sanatorium apparently cured to return to employment in a factory or workshop is extremely dangerous. Out-door occupa-:tions are the only ones in any way suitable, but it is not always possible for these to be obtained. Always medical supervision is absolutely essential. For such a purpose, tuberculosis colonies where suitable employ-:ment is offered, may yet find an important place among Public Health schemes. At the moment they are only in experimental stages. Failing them, the Tuberculosis Dispensary provides the necessary want.

The function of the Tuberculosis Dispensary is a very large one, for it has to deal with every type and stage of the disease. At the head is a specially appointed physician who may be termed the Tuberculosis Officer. This officer must work in close touch with the Medical Officer of Health, to whom under existing arrangements notifications are sent. The duties of the M.O.H. are, so far as Tuberculosis is concerned, merely administrative, and all notifications of the dis-:ease having been duly recorded for statistical purposes, should be passed on to the Tuberculosis Officer.

It is then for the Tuberculosis Officer to determine the extent of local authority interference needed. In any case, he ought to examine the house from/

from which the notification comes. If the premises are suitable, and the case is having sufficient atten-:tion and carrying out prophylactic measures with scrup-:ulous care, it may safely be left alone. At the same time all contact cases should be examined, and to this end, the whole history of the case should be carefully noted and every endeavour made to trace the source of infection.

In the absence of more stringent legislation it is frequently not possible to carry out all this. Where the patient is in good circumstances any attempt to probe the matter is looked upon, not only by the patient, but unfortunately too often, by the physician, as an unwarrantable interference. The rich man is no less liable to spread infection than the poor man, and in those places where one might expect to find enlight-:enment, and good "common sense", one frequently meets with ignorance and stupidity. For those cases, however, that require supervision the whole machinery of the Tuberculosis Dispensary is available.

In the first place, the case should be fully investigated and its future disposal determined upon. All stages and all forms of the disease are within the scope of the Dispensary, and the Tuberculosis Officer shall advise when, and what form of institutional treat-:ment is necessary. Once the Dispensary has establish-

:ed/

:ed contact with a patient it must never lose touch with the individual or the family.

Accordingly, if Sanatorium treatment is ad-:vised, whenever the patient is discharged from the institution, he should periodically attend the Dispen-:sary, where his future progress will be carefully watched. Cases that do not go to hospital will attend for examination throughout, or be attended in their homes while necessary medicines and appliances e.g. sputum bottles etc. will be dispensed. Every form of examination should be available in such an institution. In the Tuberculosis Dispensary, Arbroath, the following Forms are used for noting the results of investigation:-

FORM A.

As form attached.

FORM B. Subsequent visits.

As Form on back of A.

FORM C.

Previous history. Family History and Con-:tacts.

FORM D. Contacts.

FORM E. Procedure and Progress.

FORM F. House and Occupational Enquiry.

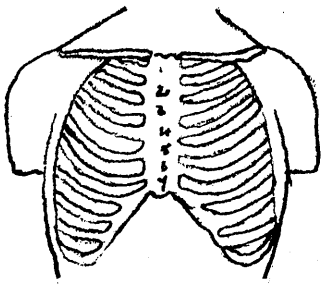
No. **FORM A.** Nat. Ins.

TUBERCULOSIS of

Notified by Dr. Date of Notification, Notification No.
Name, Age, Date,
Address, Height,
Occupation Temperature, Pulse, Weight

COMPLAINT -

Cough Dyspnoea
Spit, Night Sweats,
Pain, Wasting
Hoemoptysis,
Hoarseness,



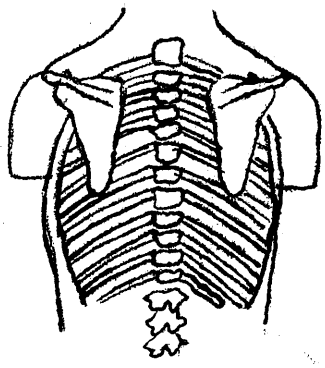
Duration,

HISTORY -

Present Illness

Previous,

Family,



EXAMINATION -

General Appearance,

Respiratory:-

Larnyx, Alimentary &c.

DIAGNOSIS -

Date	Sputum
Applied	for San. Ben.

Date	Home Cond.	Prec.

F O R M B

FIRST VISIT.

SUBSEQUENT VISITS.

Date	Weight	Progress	Treatment	Next Visit

F O R M C.

No. of Rooms
No. of inmates

Year
No.

PREVIOUS HISTORY, FAMILY HISTORY AND CONTACTS.

Date, ...

Patient's Name,..:.....Address, ...

Occupation, ...

PREVIOUS HISTORY

Tubercular (nature, age, date),

Other illnesses,

FAMILY HISTORY -

Tubercular,

P's father (family),

p's mother,

P's brothers and sisters,

P's children,

Other illnesses,

No. of Contacts in Household-

Relation to P.,

Ages, Under 15..... Over 14 .....

FORM D.

CONTACTS.

Date of Examination,

No.	Name	Age	Relation to Patient.	Same Room.	Same Bed.	Result.	Action taken.

F O R M E.

Age Year

Sex PROCEDURE AND PROGRESS. No.

Tuberculosis of

Name, Address,

Medical Attendant, Visitor,

Date	At Work	In Bed	Sep. Room	Sep. Bed	Spit. Prec.	Ven-:til-:ation.	Clean-:liness	Tub. Bac.	Means	Feed-:ing

F O R M F.

Occupation
No. of rooms
No. of inmates

Year
No.

HOUSE AND OCCUPATIONAL ENQUIRY.

Tuberculosis of Stage Date
Name Married or Single Age
Residence, Floor Rent
Nature of building, Character of neighbourhood,
Distance from other buildings, (a) infront (b) at back
General state of Repair, Underground (feet)
General cleanliness and tidiness,
Common Stair (repair, light, ventilation, cleanliness),
Common Passage (" " " "),
Areas, Back Courts,
How long in present house,
Previous address (if removed within two years),

NO. of ROOMS, No. of beds-open ; enclosed, ; cots,
No. of inmates (including P. and lodgers, Ages - (a) under 14 years
(b) over 14 years
Furnishings, Chimneys, Windows,
P.'s SLEEPING ROOM - Size Aspect, Chimney,
Windows, hung, open (a) day, (b) night,
Bed (open or enclosed), Separate Bed, Separate room,
Is P. confined to bed? Nursing by adequate,

SPUTUM - Disposal, Sputum bottle wanted,
Disinfectant wanted, Care of eating utensils
Wet dusting, Clothes washed
Precautions at work,

ILLNESS BEGAN - (a) Slightly in (b) distinctly in
Doctor first consulted in Chill-overwork-worry,
P's habits - Alcohol- Smoking- Late hours-
Overwork- Worry- Open-air exercise-

G- Good. M-Medium. B-Bad.

Continuation of FORM F.

MEANS OF SUPPORT-

Wages of P., Wages of rest of household,
Means of support when P. not working,
Nat. Ins. Poor relief, Club,
Means adequate, Dependants,

MILK SUPPLIES (for 6 months)-

Before illness (if P. under 15),

SOURCES OF INFECTION-

(a) Infant feeding, Health as child
(b) Tuberc. in household,
(c) Tuberc. in previous occupants of house,
(d) Illness in workroom,
(e) Other sources,

FAMILY HISTORY-

OCCUPATIONAL ENQUIRY.

OCCUPATION (when P. took ill), Entered, Left
Nature of Patient's Work, Wages,

PRESENT OCCUPATION - Entered
Nature of Patient's Work, Wages,
Hours Weekly, Overtime, Night work,

REMARKS-

Not only must admittedly tuberculous cases be duly attended to, but all suspect cases must be carefully scrutinised. The frank cases, the suspected cases, the contacts, all must be regularly gone over and very careful records must be kept.

It is thus apparent that the Dispensary has a far-reaching influence and a most important role. Expressing its many functions in general terms; It serves as a clearing house, through whose agency cases will find their way to appropriate institutions, or receive the proper guidance and treatment. The staff comprises a consultative unit to which all persons wishing examination and advice may apply. Through its agency contacts and early cases, and sources of infection are found and investigated. It keeps every case under supervision from the time of notification till the date of death, and supervises also the families of patients. The houses in which tuberculosis occurs are examined, and advice given where necessary.

While it is very necessary that late and chronic cases should be looked after, it is the early and eminently curable case that the Dispensary is always searching for. The scope, therefore, embraces two distinct functions:- to examine and treat each case <u>for its own</u> sake, and to supervise <u>for the sake of others.</u>/

others.

In dealing with cases, the following is the method of supervision which I employ:- Each patient presents himself at stated intervals at the Dispensary where he is weighed by the Nurse, and the weight noted. He is then required to give an account of his progress since the last visit, every symptom however trivial being noted on his sheet. Special attention is paid to the frequency and severity of cough, quantity of sputum, presence or absence of sweating, state of appetite and digestion, pain, dyspnoea, tongue, voice and bowels. Patients very readily learn to give an account of themselves, and the tendency to conceal any symptom soon vanishes. At the same time they are asked about their habits of sleeping, out-door exercise, and the time of retiral at night. The patients are examined in rotation, about once in six weeks, and the sputa once in three months. As regards contacts, these are fully examined immediately upon notification, and noted either: "Positive", "Doubtful", or "No definite signs." Positive cases are at once actively dealt with, "doubtful" cases are directed to return at a date, not more than one month from that of first examination, while those with no definite signs are directed to return in six months. For doubtful cases treatment/

treatment is always provided.

Where cases are unable to attend at the Dispensary, they are examined in their homes, at regular intervals, and advised as regard the conduct of their lives.

In prevention, the Dispensary has manifest-:ly a much more important part than the sanatorium. The latter deals only with frank cases that present some hope of improvement; the Dispensary deals with all cases, definite and doubtful. Furthermore, the Dispensary guards in every way possible against the dangers of spreading the disease, while the sanstor-:ium is concerned solely with the case under treat-:ment. With a little more legislative assistance, the Tuberculosis Dispensary, staffed by experts, would go a long way towards checking the spread of this dreaded disease.

The whole question of cure and prevention is one of great interest, largely, if not entirely, by reason of the many difficulties it presents. Some of these difficulties I have endeavoured to point out. Having faced them, and sought for a solution, I am convinced that the only salvation, for that large proportion of potential sufferers lies in an early and accurate diagnosis. It has been accepted as

an/

an axiom that by far the greatest proportion of cases acquire their infection in childhood, and in this theises, it is my intention to give a general account of the question of tuberculosis in children of school age, with special reference to the manifestations in early cases and early diagnosis of the disease.

P A R T II.

THE EARLY DIAGNOSIS OF TUBERCULOSIS IN SCHOOL CHILDREN.

DIAGNOSIS.

From what has already been said, it is evident that the diagnosis of Tuberculosis must present many difficulties. Hippocrates described the disease in a form and stage at which the veriest tyro could scarcely be deceived. Between health and this stage of frank disease, there are many forms which may puzzle and defeat the greatest master of diagnostic technique. Yet, it is with such cases that we should be most concerned, for, upon the recognition of them and the removal in them of the disease and the danger of infection/

infection, depends the ultimate success in endeavouring to remove the scourge.

The point of greatest importance therefore, is whether the disease in any individual case is active, or latent, or occult. Crocket of Bridge of Weir Sanator-:ium maintains that it a great mistake: "in a suspected case of tuberculosis to fly to the stethoscope, to X-rays to the sphygmomanometer, or to the various techniques of the laboratory. In later stages of the examination, these may be invaluable." He goes on to say further, that:- "It is possible to go round the patients in a sanatorium, and by merely looking at them, and occasion-:ally applying the hand, to tell five things:

1. "Whether or not that patient has tuberculosis.
2. Whether, if that disease is present, is is acute or chronic, old-standing or recent.
3. How far the disease has advanced.
4. The degree to which it is incapacitating.
5. The probable ~~diagnosis~~ prognosis."

No one who has seen Dr. Crocket at work can fail to have a profound admiration for his powers of diagnosis. At the same time one feels justified in expressing some disagreement with his dictum. He has however, to some extent saved the situation by the words "in a suspected case of tuberculosis," for it is with the unsuspected case that we are the more concerned.

The/

The eye, the hand and the stethoscope may allow us to visualise the happenings within the boney thorax, but, by the time the eye can perceive, the hand can feel, the ear can hear, the case has become one, dangerous to his neighbours, and not very hopeful for himself. We would modify the first and second things Dr. Crocket wants to know in any individual case, to read as follows:-

1. Whether or not the patient has tuberculosis.
2. Whether the disease is active, or latent, or occult.

TUBERCULIN DIAGNOSIS.

The tubercle bacillus belongs to a group of organisms that do not, to any extent, secrete soluble toxins, but which have the power of producing effects on the body at some distance from the site of deposit. Not only can injection of dead bacilli produce local lesions, but the disintegrated protoplasm of the organisms can produce pathogenic effects. The substances capable of producing such pathogenic effects, and which are probably of the nature of endotoxins were exploited by Koch shortly after his initial discovery. He prepared them by artificial means, and gave to them the name "tuberculin". His original idea was to use them as curative measures, the rationale being that when injected, the reaction produced/

produced, added to that of the bacilli already present, would so increase the necrotic effect, that the ulcer-:ation would result in the throwing off of the offend-:ing organisms. Success has not attended these efforts, but the tuberculins have proved of great value in diagnosis, especially of latent forms of the disease, and in early immunisations. The action is extremely complicated, and is not clearly understood.

The chief forms of tuberculins in use are as follows:-

1. Koch's Old Tuberculin. This is prepared by taking a culture six weeks old, of tubercle bacilli in five percent glycerin bouillon, evaporating to one tenth its volume, killing the organisms by heat, and filtering.

2. Tuberculin-O.-Surface cultures are made on agar; masses of bacilli are taken from the surface, dried in vacuo, ground in an agate mill, treated with distilled water and centrifugalised. The clear, supernatent fluid is the tuberculin.

3. Tuberculin-R.-. The deposit from Tuberculin-O, is again ground up in distilled water, and centrifugalised, and the clear fluid taken off. This is repeated again and again until no deposit remains. The various supernatent fluids are mixed and centrifugalised, this mixture being the tuberculin.

4. Koch's New Tuberculin (B.E.):- This is prepared by grinding/

grinding a bacillary mass in 50% glycerin and water, till a clear fluid is obtained.

5. Tuberculin Beraneck, - an extract of tubercle bacilli with 1% Phosphoric Acid.

In the experimental work that has been done with these and other less important preparations, it has been found that a supersensitiveness to the toxins of the tubercle bacillus does exist. Supersensitive-:ness is a condition allied to immunity but presenting certain contrasting features. It may be "natural" or "acquired." Apparently the only substances possessing this power are of a protein nature. Thus, the whole phenomena of reaction to Tuberculin depend upon the fact that a patient possessing a focus, active or latent, in which the porteins or protein derivatives of tubercule bacilli, living or dead, are present, has a supersensitiveness or special susceptibility to these proteins as contained in Tuberculin. The term allergy is applied to this condition.

The great value of Tuberculin diagnosis in cattle, in which tubercles may exist without giving rise to any symptoms, has been proved all over the world.

In human beings, the results of application of these tests have been looked on with much suspicion in/

in some quarters, but it is now fairly generally recog-:nised that they are valuable, not so much in demonstr-:ating the tuberculous nature of any given lesion, as in proving that tuberculosis does, or does not exist in a certain individual. Thus, it would not, if positive, imply that a particular group of enlarged glands were affected with tuberculosis and not Hodgkin's disease, but it would mean that the individual had somewhere in his body a focus of tuberculosis.

With original tuberculin, the reaction is as follows:- When an injection of, say, 0·01 c.c. is given, there appear, in from four to twenty-four hours, malaise, slight pynexia, tendency to cough, and redness at the site of injection. If a local tuberculous focus e.g. lupus, exists, intense redness occurs round it. In a healthy individual, with a similar dose no such reaction would occur, but, if the dose should be 0·25 c.c., symptoms similar, but milder, would occur.

If a concealed lesion is present, there is an increase in the physical signs, while in the case of lung disease, râles previously absent, often appear; cough and spit are increased; and bacilli may be found in the sputum though not present before the injection. The results may not be looked upon as absolute negatives, or absolute positives, but when it is/

is considered that 85 to 90 percent of the results are true, the test may be regarded as relatively reliable.

The Cutaneous Tuberculin Reaction of Von Pirquet and the Ophthalmo-Reaction of Calmette are but modifications of the original method. In the Von Pirquet test undiluted "old" tuberculin is used, the skin of the forearm being scarified through a drop placed upon it After a few hours the reaction, if positive, begins. Inflammatory redness and swelling appear round the site of scarification, and in twenty-four hours a distinct red papule is present, with a paler centre, sometimes showing minute vesicles. By forty-eight hours the maximum is reached, after which the reaction recedes.

For Calmette's Ophthalmo-Reaction original tuberculin is again used, but it is purified by precip-:itation with 95 per cent alcohol, the precipitate being then dissolved in distilled water. This is done three times, the final solution being standardised to 1% strength. A drop of this is instilled into the conjunctival sac. and allowed to spread over the sur-:face. For children 0·5% solution is sufficient. "When the reaction is positive, after a period of from six to twenty-four hours, the conjunctiva begins to show a slight hyperaemia as detected by comparing with the other eye. If the reaction is slight, there is only/

only a faint redness of the conjunctiva. If it is more severe, the redness becomes more intense, and a fibrinous exudate appears, while if the reaction is severe, the follicles of the conjunctiva are seen very distinctly and a purulent secretion may appear. These reactions are accompanied by the ordinary symptoms of conjunctival irritation, a photophohia and a feeling as though a foreign body were present in the eye. These symptoms usually pass away by the fourth day in slight and moderate reactions, although in severe reactions they may last for two weeks."
Von Pirquet announced his observations to the Berlinger Medizinische Gesellschaft on 8th May 1907, while Calmette reported his findings to the Academie des Sciences on June 17th of the same year.

Carl Spengler introduced a method for therapentic purposes of causing absorption of the tuberculin through the skin. This was, in 1907, modified by Moro to suit purposes of diagnosis. He uses a tuberculin ointment made up of equal parts each of tuberculin, and anhydrous wool fat. In the pre-:paration, the lanolin has to be heated to between 20 °C and 30 °C, and, if stored in a refrigerator will keep potent for months. It is most convenient for use if packed in collapsible tubes containing about 2 grammes. The ointment is rubbed into the skin,

preferably/

preferably that of the abdomen, for half to one minute over an area of about 5 c.m. and the part is left exposed for some time. Three main types of reaction occur: (a) Slight, "miliary reaction", showing "single or numerous isolated, more or less distinct reddened spots, which are only visible on the most careful inspection and disappear in a few days.", (b) "confluent reaction" in well marked cases, showing distinct papules, as in Von Pirquet'Test, and (c) vesicular reaction, in which red nodules arise on an inflamed base, sometimes with a "head" filled with turbid fluid.
In addition, there are of course, reactions showing mixed features of any or all of these. The severe reactions may show itching and may last several days, but as a rule the reaction occurs between twenty-four hours and forty-eight hours, fading after that time.

INTERPRETATION of RESULTS.

In reading the results of a tuberculin test, many factors have to be taken into consideration. A positive Wassermann Reaction will, almost without exception, lead us to pronounce a particular lesion syphilitic, and will, taken in conjunction with the clinical appearances, determine the treatment. Is such an assumption justified in the case of these tests for/

for tuberculosis, and would a negative result rule out this disease as the cause of the focus? Can a positive result tell us whether the disease is latent. inactive, or latent active? Can any conclusion be drawn as to the stage of the disease? Is it possible to formulate a prognosis from the result of the test? Are all the tests mentioned equally reliable?

Of Von Pirquet's reaction it can only be said that it indicates ~~only~~ that the individual has at some time, somewhere been infected with tuberculosis, and gives no indication of the site of the disease, nor of its activity or inactivity. In the case of adults, a severe reaction which disappears slowly would lead us to make a very thorough examination and to keep the patient under strict observation, but in children, a positive result of any kind should call for active prophylactic measures.

In an endeavour to increase the value of the test from a diagnostic and prognostic point of view, attempts have been made, notably by Ellermann and Erlandsen, to devise a quantitative method of application. Various dilutions of tuberculin were used to determine the minimal dose which would produce reaction. Tested, however, by many independent observers, this method has failed to achieve its object, and has been more/

more or less rejected as of no practical value.

Calmette's Ophthalmo Reaction is rather less reliable than the cutaneous test. In some cases of obviously active disease it fails to react, while sometimes a reaction will at once be obtained in a person clinically sound. A single instillation seldom produced reaction in the initial stages of disease. Consequently though the conjunctival reaction is certainly specific, depending upon an allergie of the conjunctival tissues to tuberculin, when positive it indicates only the presence of tuberculous infection, and when negative does not prove the absence of the disease. As an index of the activity or non-activity of the disease it is of no value whatsoever.

Moro's percutamous reaction is very similar in its results to the method of Von Pirquet, though it is rather less sensitive. In children under the age of six months it almost regularly fails to react, but from this age till 10 or 12 years, it is more valuable than in the case of adults. Much naturally depends upon the state of the skin, for an athropic, dry, coarse or scaly skin will almost always yield a negative result. While a negative result then cannot be construed as a conclusive proof of the non-existence of tuberculosis, the positive reaction

only/

only establishes the existence of a tuberculous in-:fection, and tells nothing of the state of latency or activity.

In the subcutaneous method the injection requires to be repeated, and the dose increased from an initial small one. The dose, however, should only be increased when the previous injection has pro-:duced no reaction. A positive result points only to the presence of a tuberculous infection, which may be latent active, or latent inactive, and gives us no information whatever as to the situation, extent or activity of a lesion. At the same time, the value of this test is considerably greater than that of any of the others mentioned, because the dosage is more exact, and absorption more uniform. The conclusion may be fairly justly drawn, nevertheless, that a reaction to the smaller doses indicates relatively active disease: an early reaction, recent processes; and a late, sluggish reaction, chronic lesions.

In all the tuberculin tests, certain con-:ditions are found to invalidate the results. Thus, while "Surgical" tuberculosis will generally give an early and strong reaction, miliary lesions very frequently produce no reaction at all. This is of great importance in children in whom tuberculous meningitis/

meningitis is of common occurrence. Furthermore, in very advanced cases and cachectic states, the tests generally fail, while the acute infections always tend to decrease the value of the reaction.

What then, is the absolute value of tuberculin in diagnosis? A positive Widal reaction is Typhoid and a positive Wassermann test in Syphilis, will indic-:ate the presence of the B. Typhosus on the one hand, and of the Spirochaeta Pallida on the other. In the presence of "rose-spots" in the first case, or a gener-:alised skin-rash in the other, a diagnosis will be established. The position is really very similar in regard to tuberculin tests. One of the "Obiter Dicta" of Sir James Kingston Fowler is:- " tuberculosis dispensary that has become a "tuberclin" dispensary, has become a very dangerous place." No one is going to go round the community indiscriminately administer-:ing doses of tuberculin, and hoping thereby, to achieve anything in the way of removal of the trouble. Throughout the length and breadth of the science of Medicine, it has to be ever borne in mind that the absolute rule, the infallible remedy, the definite decisive factor, do not exist. In the words of Corrigan: "The trouble with most doctors, is not that they don't know enough, but that they don't see enough." Yet seeing is one thing, and reading what you see is another/

another.

The wholesale use of tuberculin, and the indiscriminating interpretation of results, would not only be valueless, but would be positively harmful. Yet we have seen that many children infected with tuberculosis pass quite unnoticed, and we have observed that the phenomena of anaphylaxis make possible in diagnosis, the application of various tests. In what way, then, are these tests to be apportioned their rightful value?

A. Family History. On entering the wards of a hospital for clinical teaching, the first thing we are taught is the method of "case taking", and family history is alloted a large part of the case sheet. One wonders how many general practitioners trouble much about family history, once they have left the graduation ceremony armed with a diploma to practise medicine? Too much stress cannot be laid upon the family history, nor upon the method used in finding it.

Do we ask a patient suspected of suffering from tuberculosis whether any of the family have suffered from this disease, the answer will, almost without exception, be in the negative. The method I employ at the Tuberculosis Dispensary, Arbroath, is as follows/

follows:- "Is your father living? How old is he? Is he healthy? What disease, or injuries, has he suffered from? Has he any scars? What caused them?." The same questions are asked regarding the mother, the brothers and sisters. In the case of any who have died, the cause of death is asked, and where possible verified. The replies are checked by interrogating the members of the family; and the history, wherever possible, is carried back to the previous generation. Special attention is paid to such diseases as Asthma, Bronchitis, Pleurisy, Measles, Whooping-Cough, Enlarged Glands, and vague abdominal and cerebral conditions. Tuberculosis or suggest-:ive conditions in the family history having been found, - and this applies not only to suspected, but also to unsuspected cases, e.g. contacts, - a complete examination falls to be carried out. In such cases a positive tuberculin test is of great importance.

Thus, in the family of W.S. aged 4.9/12 years who died of tabes mesenterica, a brother aged 3.6/12 years, gave a positive reaction to Von Pirquet's test, while a sister aged 2 years, gave a negative reaction. Considering that the reliability of the test is roughly in inverse ratio to the age of the child, this was looked on as an important result, and the boy was at once, and in the absence of clinical signs, put under observation/

observation, and prophylactic measures were recommended.

In the case of G.M. aged 10 years, the father died of tuberculosis, while the mother suffered from Asthma. Tuberculin tests were carried out because the boy suffered from cough, without any definite physical signs. The reaction was strongly positive, and the boy kept under strict observation. A few weeks afterwards he suddenly developed a febrile temperature with delirium, and the cough increased. A small patch that might have been covered with a florin, was discovered below the angle of the right scapula, manifesting dulness to percussion, harsh "bronchial" respiratory murmur, bronchophony, and scattered crepitations. Hospital treatment was refused, and the boy improved. The temperature, in the course of a few days, returned by lysis to normal, but the cough did not disappear, though the physical signs did so. Six months later a similar attack occurred accompanied by marked wasting. This time he went to hospital and did very well, being discharged with a gain of 8 lbs. in weight and an absence of cough after five months' treatment. In connection with this family history, a further point of interest may here be noted. A stepbrother of G.M. aged 3 years, was/

was obviously out of sorts, but demonstrated no definite signs. A Von Pirquet test was carried out with negative result, but three days later the child developed all the symptoms of measles, which was followed by tuberculous adenitis.

These cases are selected at random from my case-book, but such instances of the importance of a positive reaction with tuberculin, where tuberculosis occurs in the family history, could be indefinitely multiplied. On the other hand, a positive reaction in other members of a family may frequently be taken as a priore evidence of the true nature of a suspected case, where this case also gives a positive result.

In the case of children, the younger the child the more likely is the disease to be present in an active form. As stated, the tests are seldom valuable in sucklings, in whom a negative result is generally found. Thus in contact cases, active, or latent active tuberculosis is likely to be discovered much earlier when tuberculin is used along with other methods, than when other methods alone are employed, and this is of greater importance in children, than in adults. At the same time, it must, even in very young children, be fully realised that a positive reaction to any of the above tests does not prove the tuberculous nature of swollen joints, enlarged glands, or/

or tumid abdomens, but merely indicates that the child is somewhere harbouring a nest of tubercle bacilli. In children under five years of age, the disease is very probably active, but over this age, no conclusion can be drawn as to the state of the disease.

B. LASSITUDE and VAGUE SYMPTOMS.

Apart from the family history there are many circumstances when tuberculin tests may prove of con-:siderable value. There have already been mentioned those peculiar conditions of indefinable "unwellness" which affect some children, who, in the language of the Scots, are aptly referred to as "toutie weans." These "touts" are familiar to every general practitioner and to every student of pediatrics. The child is simply unwell; refuses food; sits or lies about; will not play; becomes feverish at night; and yet, in many instances, there are no definite symptoms, and no objective signs. Such children, in many instances, are so attacked every few weeks, but between attacks are generally pale, possessed of a vicarious appetite, and prefer quiet pursuits to the games which the thoroughly healthy child enjoys. In my experience, such children almost without exception, yield a positive tuberculin reaction.

One has to remember that in phthisis the first symptom is generally not cough, but "tiredness" and lassitude. This is the case both in adults and in the young. But "tiredness" is a common symptom of tuberculosis anywhere. One finds that those subject to tuberculosis of glands are, in the majority of cases, perfectly well but easily fatigued. I am inclined, therefore, to view the great majority of children affected in this way, as carrying somewhere, a focus of latent active tuberculosis. Very frequently at any rate, when these children fall victims to one of the acute fevers, they have sequelae pointing to a tuberculous origin.

There is a great temptation for the busy practitioner to thrust all cases where the complaint is tiredness and loss of appetite onto the great scrap-heap labelled "Anaemia." In adults and children alike, but in the latter much more than in the former, tuberculin tests might yield instructive results. There exists here a great field of exploration for the persevering observer.

C. WASTING.

Apart from such cases, we find, every here and there, children that are wasting from no obvious cause/

cause. I am inclined to group cases of wasting under the following heads. 1. Syphilis, 2. Congen-:ital Heart Disease, 3. Rheumatism, 4. Indigestion, 5. Mal-nutrition due to improper or insufficient food, 6. Diabetes, 7. Worms, 8. Latent tuberculosis. A single application of the stethoscope will prove whether or not the heart is normal; the history, the state of teeth, skin, ribs, and fontanelles, with Wassermann test where doubt still exists, will elim-:inate syphilis; the urine will suffice to prove the existence or non-existence of diabetes; a watch on the diet will deal with malnutrition; worms can be seen; and rheumatism will perhaps be self-evident. We are left with tuberculosis, apparent or unapparent; some cases of "rheumatism" which may not be rheumat-:ism; and indigestion and malnutrition which dieting will not improve. Of the "rheumatic" pains and "growing" pains, some may be syphilitic, some may arise from osteomyelitis, and some may be tuberculous. Indigestion again, may not be due to a defect in the gastric secretions, or to improper food, but may arise from the major disability.

The conclusion then is: Where in children wasting exists and no obvious cause can be found, test with tuberculin. A positive reaction only means that/

that tuberculous infection is present, but in such a case it may be read to imply that the tuberculosis is latent and active. We may not feel justified in notifying the case, but the positive reaction, - and again, the younger the child the greater the value of the reaction, - would lead us to adopt active anti-tuberculosis methods.

Viewing the tuberculin tests as a whole, we must come to a clear understanding of how much reliance has to be placed upon them. As a single and distinct means of arriving at a diagnosis they are valueless. As part of a complete examination to clinch the diagnosis in a suspected case, and to give a clue to the possible cause of that which is vague and uncertain, they are superlatively useful. To epigrammatise: Great is the power of tuberculin when used with discrimination! Let the diagnosis never be based on tuberculin minus clinical evidence; may the case not be so serious as to let the diagnosis be based on clinical evidence minus tuberculin; but let us, in the future hope to find a just admixture of methods bringing more, and earlier cases under observation.

OTHER SPECIAL METHODS.

Before passing on to a detailed discussion of

the/

the diagnosis it would be well to consider other special methods that have, from time to time, been tested. The disease is a germ infection, and the majority of patho-:genic organisms are capable of producing some degree of immunity, or, at any rate, of causing in the body of the host certain processes which are more or less specific for the special bacterium. It is well known that many persons affected with frankly active tuberculosis do recover, and this frequently, indeed generally, when they are merely given the best hygienic dietetic conditions for building a sound body. Further, it has been shown that tuberculosis frequently lies dormant in the body for many years. Why does one person succumb, another recover; why do some manage to retain the infection in a state of dormancy, and some have an active disease?

There would seem to be more in this than mere hygiene. Even in a sanatorium, where all are under the same conditions of life, we find some patients quickly over come their infection, and others, who on the date of admission seem to have a less advanced disease, go steadily downhill. In 1924, on the same day, I admitted to hospital two patients of between twenty and twenty-five years of age. In the one case, there was considerable cough and expectoration; a constantly febrile temperature rising at night about one and a half degrees/

degrees; considerable sputum showing tubercle bacilli in large nnmbers; and a large area of consolidation in the upper lobe of right lung. The other case complained of lassitude and slight cough. Physical signs were confined to a slight impairment of the percussion note on the left side at the apex, with a harshness of the respiratory murmur. There was no elevation of temperature, and bacilli were scanty in the sputum. Considering these two cases one seemed justified in giving a better prognosis in the second case, than in the first. They had opposite beds in the same ward and were under identically the same conditions. The first case was discharged after six months with an increase of weight of 16 lbs. no cough, no sputum, no elevation of temperature; while eight months after admission, the second case died, having throughout the course of treatment, lost ground daily.

In the face of such evidence, it is justifiable to assume that there is something inside the body which determines these vagaries. In laying anything at the door of "variable virulence of the germ" we are only begging the question.. We have no possible right to talk so glibly of the virulence of germs. That there is some variation in virulence is probably true, but/

but there must be other factors at work. Nevertheless we have at present, no clear idea of the processes producing such results. The whole question is bound up with that of immunity, which may with advantage be briefly reviewed.

IMMUNITY.

By immunity is meant non-susceptibility, acquired or natural, to a disease producing organisim or its toxins. Many diseases produce immunity from further attacks, and the same result can frequently be obtained by repeated, non-lethal doses of the attenuated organism or its toxins. The process of immunisation seems to be going on during the progress of the disease, and when it has reached a certain stage the disease naturally terminates. Acquired immunity is sub-divided into active, and passive. Active acquired immunity is that type which follows an attack of certain fevers, e.g. Scarlatina, Diptheria, Smallpox, and depends very largly upon the action of lencocytes, which ingest and destroy the bacteria. This process is spoken of, - after Merchinkoff - as Phagocytosis. There appears to exist in the bacilli a positive chemiotaxis, which attracts the/

the phagocytes to them. While this process is going on, the polymorpho-nuclear leucocytes increase greatly in numbers, and put out a ferment into the blood-serum, apparently for the purpose of preparing them for the phagocytic ingestion. This substance is termed an opsonin. In such cases, the success of the patient's fight against the disease, and the subsequent freedom from attack depend upon the quantity of opsonin present in the serum.

Passive acquired immunity is a more complicated and less certain process. The rationale is that, when a pathogenic organism is present in the body, the reaction between it and the tissues of the host, produces substances which, when injected into another susceptible animal, protect it. These antibodies as they are called, include antitoxins, which tend to counteract the effects of the specific toxin: agglutinins, which cause the bacteria to be grouped together in masses; and bacteriolysins, which cause the disintergration of the organisms.

Most of these processes can be made use of in therapentics, and some have proved, in the case of certain diseases, of great value in diagnosis. This is made possible by the fact that more than one substance is necessary in the serum to effect immunity. There is found/

found, not only the bacteriocidal substance, or immune body, but also, a substance commonly called the complement, which so acts on the organism as to make it more easily destroyed. The immune body only appears in the presence of a specific virus, and is a stable substance capable of resisting high temperature, while the complement is unstable, though normally present in the serum, and is readily destroyed by heat.

COMPLEMENT FIXATION METHOD.

The peculiarity of the complement has been made the basis of certain tests for the presence of immune bodies, - the Complement Fixation method. This phenomenom falls into the class of lysogenic action. Thus, an immune serum will destroy organisms by bacteriolysis only in the presence of the complement, which is fixed or used up in definite quantities. Not only may an immune serum produce lysis of bacteria, but it may be used to produce lysis of red blood corpuscles. The presence of immune bodies or amboceptors, may be tested by adding the serum heated to 55 °C, to the corresponding bacterium, incubating at 37 °C, and then adding sensitised red blood corpuscles and incubating again. If an immune body or amboceptor is present, no lysis

will/

will take place, because the complement has been "fixed" by the bacteria and immune body in the first instance. Sensitised blood-corpuscles are those treated with sufficient immune-body to produce lysis in the presence of complement, (Bordet and Gengou.)

On these phenomena is based the well-known Wassermann Reaction. Wassermann, Neisser, and Bruck were the original workers in connection with the "specific" reaction of Syphilis. They mixed together a watery extract of syphilitic liver rich in spirochactes, constituting the antigen, and serum from a syphilitic case. Sensitised corpuscles failed to undergo lysis, proving the fixation of complement in the first instance. It has subsequently been found, (Marie and Levaditi) that normal guinea-pigs' liver will do as well as an extract of syphlitic liver. The method is as follows:- Serum from a suspected case heated to 55 °C is added to an extract of guinea-pig's (or ox's) liver, along with fresh serum. This is incubated at 37 °C, and sensitised blood-corpuscles are added, the whole being again incubated. If no lysis occurs, the test is positive.

Many writers have applied this test to the diagnosis of tuberculosis, but the results have been very disappointing. So far as investigations have gone/

gone , it has been found that the serum of persons, clinically non-tuberculous, frequently show the same phenomena of complement deviation as the serum of cases of manifest tuberculosis. Although this may appear to invalidate the test entirely, it is possible it does not do so. Every case which gives a positive Wassermann Reaction, does not by any means demonstrate the well-known character of Syphilitic lesions. If over ninety percent of the population harbour the tubercle bacillus, then over ninety per cent have developed in more or less degree an immune body. A frank negative would thus be of much greater value than a positive reaction.

AGGLUTINATION.

In some other infective diseases, agglutinins in the blood-serum have proved of great value in diagnosis. Notably is this the case in Typhoid Fever. It has been found in tuberculosis, that the serum of a tuberculous patient exerts an agglutinating action of the tubercle bacillus. Working upon the proven importance of the Widal test in Typhoid, many workers notably Arloing and Courmont have attampted to apply these principles to the diagnosis of tuberculosis. The great difficulty to begin with was to obtain a homogeneous/

homogeneous suspension of the organisms. They got over this difficulty by special cultural methods, viz: the growth on glycerin peptone broth of old cultures which were shaken up to ensure distribution and yield a homogeneous mixture. Koch and Rumberg found that dead cultures were equally satisfactory. A mixture of suspected serum, with one or other of these preparations in portions of 1 in 5, 1 in 10, and 1 in 20 are examined for clumping at twenty-four hour intervals.

Some observers have been enthusiastic about the results, while others have been definitely sceptical showing that clinically healthy sera give the same reactions as tuberculous. The general conclusion at present is that: "the phenomenon of agglutination of tubercle bacilli by blood serum, is an important criterion of the formation of specific immunising reaction products, in the specific treatment of tuberculous cases by means of tuberculin, but as a diagnostic measure, especially in early cases, it is absolutely worthless, because the serum of an active tuberculous case frequently contains no agglutinating properties, while, on the other hand, the blood of a case of infection, already a long time quiescent often shows a positive reaction." Indeed, this test might prove of great value in prognosis, for agglutinin appears/

appears only to develop in the presence of arrested disease, and not of progressive.

OPSONIC INDEX METHOD.

Of the three groups of processes occurring in active acquired immunity only one now remains to be con-:sidered namely phagocytosis. It has been already stated that a substance appears in the serum, - porbably from the polymorpho-nuclear leucocytes - which prepares the organisms for ingestion and destruction. Such substances are termed opsonins. Wright elaborated a method for determining the opsonic power of a serum, and this has been applied to tuber-:culosis for diagnostic purposes. The technique includes: (1) preparation of the bacterial emulsion, (2) preparation of samples of (a) serum from a normal person, and (b) serum from the infected person.

The serum of most human beings and of many species of animals contains opsonins to the tubercle bacillus. In persons suffering from tuberculosis, these opsonins are frequently diminished, and for pur-:poses of comparison between infected persons and healthy, samples of serum from apparently non-tubercul-:ous individuals are mixed together. The bacillary emulsion is obtained, in Wright's method, from a 7-10 days/

days culture in glycerin-broth, which is sterilised by heat, collected on a filter, washed with saline, and dried. Ten milligrams of this preparation are powdered in an agate mortar, a drop of 1% salt solu-:tion is added, and the resultant paste triturated for about five minutes. Saline is added drop by drop till about 1 c.c. of emulsion is obtained. After centrifugalising, the super-latent fluid is withdrawn and diluted to the required extent.

Leucocytes are taken from the observer's own blood, which is allowed to flow into a 1·5% sol-:ution of sodium citrate in ·85% sodium chloride. After centrifugalising, the corpuscles are washed with saline, and the upper layer of leucocytes withdrawn by a pipette.

Two mixtures are made, of equal parts of emulsion, leucocytes and serum, in the one normal serum being used, in the other the serum under sus-:picion. A small quantity of each is placed in a capillary tube and inoculated at 37 °C for fifteen minutes. Film preparations are then made from each, the films being fixed and washed thoroughly, stained with carbol-fuchsin, decolorised with 2·5% sulphuric acid, cleared with 4% acetic-acid, washed with water, and counter-stained with watery solution of methylene-blue.

Under the microscope the number of bacteria in the polymorpho-nuclear leucocytes is counted, at least a hundred leucocytes being observed. The aver-:age per leucocyte is then taken, and thus the propor-:tion which this average in the case of the suspected serum, bears to that in the normal serum, gives the opsonic index. Using the mixed sera as described, an index of under 0·8 may be taken to indicate a def-:iciency, while an index of over 1·2 denotes an excess. In generalised tuberculosis, the results vary considerably, while in strictly localised cases the index is generally below 0·8. The conclusion drawn from these observations is that, if the opsonic index is below or above certain limits the presence of tuberculosis may be regarded as established. The technique, however, presents very great difficulties and is laborious, so that the test is generally looked upon as of little diagnostic value except in the hands of highly practised and expert observers.

PASSIVE ANAPHYLAXIS.

The phenomenon of passive anaphylaxis has also been used as a diagnostic measure. This depends upon the fact that, if an animal, say a guinea-pig, is injected with a minute dose of a certain serum, and,/

and, after a number of days, - usually ten, as a min-:imum, - is reinjected with a larger dose, severe symptoms develop. Restlessness and hyperaglesia are present at first, followed by signs of collapse, with a fall of temperature, incontinence of urine and faeces, with great weakness of pulse and respiration.

It has been found that healthy guinea-pigs into whom the serum of a tuberculous individual has been injected, will, on subsequent injection of tuberculin, show the phenomena of anaphylaxis, and it was thought that a specific diagnostic test was here established. The results, in practice, however, have not been found reliable.. Certainly, without exception the result in tuberculous cases is positive, but other sera have also been found to yield a positive reaction. The method, therefore, has no specific value in tuberculosis.

COBRA-VENOM REACTION.

Calmette devised what he believed to be a specific reaction with Cobra-Venom, - the cobra-venom Activation Method. When diluted cobra-venom is mixed with normal serum and red-blood corpuscles, no haemolysis of the corpuscles takes place, even when strong dilutions are used. Calmette claimed on the other/

other hand, that when blood serum from cases of pul-:monary tuberculosis was used, activation and complete haemolysis of red blood corpuscles was caused. He records 94% of successes with this test. Other authors have been unable to confirm his findings, for, though the reaction certainly does occur with tubercu-:losis they have found the same reaction in 50% to 80% of sera from clinically non-tuberculous patients, and in serum from cases of other diseases.

VALUE OF TESTS.

It is a matter of supreme difficulty to estimate the relative or absolute value of these tests. In the present state of our knowledge the agglutination test, the cobra-venom reaction, and the passive anaphylaxis test may be discarded as of no value in indicating the presence of either active or latent disease, even in the face of other suggestive features, as wasting, family history etc. The method of opsonin index estimations is certainly of some use in the hands of reliable observers. At the same time, no hard and fast line can be drawn beyond which the index can be shown to prove the existence of tuberculosis. The limits of normal phagocytosis are, so far as we know, so variable, that a fair and reliable/

reliable interpretation of results can scarcely be arrived at. Nevertheless, in the presence of sus-:picious signs and in the hands of a painstaking bacteriologist, quite valuable confirmation of a diagnosis might be obtained. In regard to the com-:plement fixation method, one may be worthy of forgiveness if one should let one's hopes run high. It is true that, up till the present, no reliance can be placed upon the results obtained. It is equally true, that we know of no means of detecting latent, inactive tuberculosis. When we discover such a means we shall have gone very far towards solving the whole problem of prophylaxis and eradication of the disease. Against the complement deviation method, the most we can say is that the serum of clinically non-tuberculous frequently show the same complement deviation phenomena as that of a case of manifest tuberculosis. Thus the test may be regarded as valueless from the point of view of demonstrating active disease, even in the presence of suspicious features. It remains for the future to tell whether it may be useful in finding latent foci in persons clinically healthy.

EARLY/

EARLY SUBJECTIVE SIGNS.

It is thus apparent that we cannot hope to make a diagnosis on the grounds of so-called specific reaction. Even if it were possible to say definitely that the disease were present, and whether it were latent-active or latent-inactive, such tests would entirely fail to indicate the localisation of lesions. Thus we return to the original premise of Dr. Crocket, that much must depend upon the eye, the hand, and the stethoscope. Recent investigations have thrown con-:siderable new light upon the old established methods, and upon the interpretations of results.

At the same time, a grave mistake may arise in stripping the patient forthwith and pursuing, in however a complete and careful manner, a physical ex-:amination. Subjective symptoms must always be looked upon as valuable guides. Much that might otherwise be vague and uncertain, considered in association with the patient's feelings may take on an entirely different aspect.

Pleurisy.

Tuberculosis has got to start somewhere, and we have seen that it generally has its primary seat in glands. Thence in a spread by lymphatic glands, continuity/

continuity of tissue or blood-stream, determines a de-:posit elsewhere. There is a multitude of conditions which pave the way for the development of tubercle, and many which really constitute the "fons et origo." The extreme frequency of tuberculosis of the lung, as a signal of pleurisy, is well known. In a large number of cases of pleurisy the onset of the disease is pre-:ceded by some exposure to cold, and to this, by patient and friends, the trouble is attributed. In persons over five years of age, at any rate, the underlying cause is almost certainly tuberculous in about half the cases. A large number of these cases afterwards die of tuberculosis, and the serous fluid from many patients inoculated into animals, produces typical tuberculous disease. Apart from local causes such as trauma, other antecedent factors are rheumatism, scarlatina, measles, influenza, Bright's disease, and pneumococcal infections in general. Among these, measles and influenza are again frequent aetiological factors in the production of phthisis.

A history of pleurisy, recent or old, is therefore of great importance in the investigation. Though the organism concerned in its production may not have been the tubercle bacillus, the chances are about equal that it was, and, if not, a weakness has been produced locally which will make the deposit of the germ/

germ easy.

Empyema.

In the case of purulent pleurisy, or empyema, tuberculosis is a very common result. Empyema is a relatively frequent sequel to pneumonia, the child, having had an apparent crisis, failing to regain normal strength as would be expected, while the temperature rises two to three degrees at night and wasting is apparent. Frequently some bulging of the thorax can be seen, and the usual signs of dullness, and absence of breathsounds prove the presence of fluid. A bacteriological examination alone will show the purulent nature of the fluid. Pneumococci staphylococci and streptococci are the organisms most usually found, but in a certain number of cases the bacillus tuberculosis is present, either alone or along with one or other of these. Certainly both pleurisy and emphyema should be looked on as suspicious events in the history.

Haemoptysis.

Haemoptysis, as an early symptom, has always been looked upon as of great importance. In children it is probably less so than in adults. It has, so far scarcely been accredited its true significance. At

one/

one time the coughing up of blood was regarded as proof positive of active lung disease, and later, the opposite view was expounded by many and it was accorded rather a doubtful place. In adults, in the absence of organic heart disease or severe strain, it may be considered as most probably due to tuberculous infection. In children it is a rare event, even severe cases seldom showing true haemoptysis. In whooping-cough it is fairly common, while it frequently results from heart disease whether congenital or acquired. In all such cases adenoids and other affections of the posterior nares, or diseases of the gums, must always be excluded. In the absence of such possible causes, however, we are justified in concluding that it points to some lung involvement, though such an opinion, when no other symptoms are found, must be guardedly pronounced.

Night-Sweats.

Night-sweating in adults is frequently an early sign, but too much importance must not be attached to it in the case of children. They sweat on very slight provocation, more especially when, from any cause, debilitated. Thus, after an acute illness, sweating at night is common, in anaemia, and, - which is of great importance, - in rickets. Profuse sweating/

sweating at night regularly occurs with empyema, but it were unwise to place much reliance upon it, as a symptom of tuberculosis.

At the same time, fever, whether or not associated with such sweating, must always be looked upon when no other cause is found, as a suspicious symptom. For a long period it may remain as the only symptom, with the exception of loss of appetite, and a tendency to lose flesh. Another very common complaint, as already pointed out, is lassitude. The patient is always "tired" and, in the case of children, disinclined for play. The appetite is poor, more or less anaemia is present, and the weight either tends to fall, or ceases to increase. In such cases, diarrhoea is quite frequently present, every meal taken being immediately followed by a more or less fluid evacuation of the bowels, and headache is common. Such a syndrome, when present, should always lead to a very thorough investigation of every symptom in the body, and to active measures directed against tubercle, whether or not a localised lesion is discoverable.

Bronchial Catarrh.

There is perhaps no condition so common in young/

young children as Bronchial Catarrh. Frequently it begins, within the first few days of life, and does not clear up completely for many years. It is marked by a more or less chronic catarrh, subject at intervals to acute exacerbations. There is no doubt that in many instances it is the harbinger of asthma, although in young children the characteristic respiratory phenomena of that disease are not evident. It is common, however, to find children the subjects of chronic bronchial catarrh, by the time they reach the age of four or five years, having attacks of respiratory difficulty.

Bronchial catarrh in children is by no means a simple condition. Although one is averse to blaming dentition for the numerous disabilities of childhood, one has again and again observed an apparent relationship between the two. Children affected with, or subject to catarrh of the air passages, frequently have an exacerbation with the development of each tooth. It is quite well recognised that catarrh of the stomach and intestine, are common accompaniments of teething; and that a kind of sympathy between the respiratory and intra-abdominal mucous membrane exists, is evidenced by the indisputable fact that bronchitis and gastro-enteritis are often co-existent/

co-existent. Young children so affected, also very readily develop emphysema, while a certain degree of pulmonary collapse with plural adhesions is a relative-:ly ferquent event. All these conditions combine to make the way clear for the tubercle bacillus to settle or, if already present, to prolificate. Therefore many cases, afterwards demonstrably tuberculous, are marked at the start by signs of bronchial catarrh, and, at the same time, the bronchial catarrh in a num-:ber of instances, is the first symptom of a tubercul-:ous infection.

MEDIASTINAL GLAND ENLARGEMENTS.

Post-mortem examinations go to prove that enlargement and caseation of the mediastinal glands is of great frequency in children, occurring even more commonly than disease of the mesenteric. From the fact that, not the higher but the lower glands in the mediastinum are those most involved, it seems unlikely that this infection in the majority of cases, is acquired by way of the cervical groups. Generally, it is probable that the infection is through the lungs, even though no lesion is found there. These foci are of special importance in that they may infect the pleura, the lung, a bronchus or the blood-stream, to cause/

cause tuberculous meningitis or miliary tuberculosis. It is thus apparent that early recognition of such glandular involvement is of paramount importance.

Diagnosis of Mediastinitis.

The general symptoms of this affection do not point to anything beyond the presence of tuber-:culosis somewhere. In other words they are not localising. The importance of this is obvious, for it means that in every examination of the chest in children, a careful search should be made for evidence of this form of the disease. In odd cases, localising symptoms may be present. These are:- (1) Inspiratory stridor, (2) a curious clanging type of cough resembling in some degree whooping-cough and also the "brassy" cough of aortic aneurism, while the general symptoms are lassitude, loss of weight, loss of appetite and irregularity of the temperature.

One has to depend, for a diagnosis, largely on the physical signs. One or more of the following may be present:-

(1) Impairment of the percussion note in the first and second intercostal spaces close to the sternum. If this is found on the right side, it may be regard-:ed as of more definite value than when on the left, for at this side a small area yielding an impaired

note/

note may be found close to the sternum, probably accounted for by the presence of the great vessels.
(2) Dullness about the root of the lung in the interscapular space. This dullness is not due directly to mediastinal glands, but is produced rather by consolidation of the lung near its root. This consolidation is very liable to occur when the glands about the earlier divisions of the bronchi are enlarged. These glands of course do not belong to the mediastinal groups, but are generally affected along with those of the mediastinum.
(3) A marked deficiency of air-entry into some part of the lung. This sign is of special importance if it involves a whole lobe, and is supposed to be due to pressure of glands on a bronchus.
(4) Increased resistance to pressure over the manubrium. In the earlier years of childhood, there is a well marked resistance, which is best demonstrated by steading the child with one hand upon the upper dorsal spines while pressure is made with the fingers of the other, on the manubrium. It is a very delicate sign, but the skilled hand can detect a loss of this resistance when the mediastin-
:al glands are enlarged.
(5) Enlargement of veins of the chest, especially noticeable in the second interspace where a large vein/

vein is seen passing inwards from the region of the coracoid process. Before attaching any importance to such an appearance it is essential that the exam-:iner should by careful observation note the appear-:ance of the skin and the veins, for often in thin, clear-skinned children, a plexus of veins exists over the front of the chest, and must not be cou-:founded with enlargement from pathological causes. The sign is principally of value when the enlarge-:ment is found on one side of the chest only, for then the other side gives a criterion for comparison.

(6) It may be possible by pressing the finger down behind the top of the manubrium to feel the upper rounded edge of one of the enlarged glands. This is very rarely accomplished.

(7) With the child in the sitting or standing position, the head being extended as fully as possible, a bruit can be heard just below the inner end of the clavicle. This sign was first described in 1875 by Dr. Eustace Smith, who claimed that the sound was a venous hum, produced by the bending back of the head causing a tilting forward of the lower end of the trachea with its adjoining glands, which thus press upon the left innominate vein. Dr. Still has found it in cases of enlarged mediastinal/

mediastinal glands, where other signs pointed to their presence, while he has sometimes discovered it in anaemic conditions and where there was no evidence of glandular disease. He regards it as of considerable value.

An early diagnosis of mediastinal adenitis is of great importance, for, though many cases recover completely a great number develop tuberculosis of the lungs, perforation into a bronchus or blood vessel, or tuberculous meningitis. Of course, the role of the glands in an early diagnosis is, in general, of great importance. Especially in children the glands customarily constitute the first lesion, from which starts a dissemination of the infection throughout the body, or a spread to vital organs. I have collected twenty-two cases in children under ten years of age where obvious glandular enlargement preceded infection elsewhere. Of these, 11 cases of cervical adenitis were followed by pulmonary disease; 5 of cervical adenitis by intra-abdominal infection; 3 of cervical adenitis by tuberculous meningitis. Two cases included in the "lung involvement", were actually finally, cases of acute miliary tuberculosis. Two cases which ultimately showed abdominal disease first had enlarged glands in the groin, while one case of

acute/

acute pulmonary tuberculosis was first treated for a tuberculous abscess in the axilla, before any lung symptoms were present. This case presented a feat-:ure of special interest, in that the lung first in-:volved was at the same side as the adenitis, viz. the right, the lesion first appearing in the lower part of the upper lobe, and later, before any disease could be found in the left lung, adenitis developed in the left axilla.

I have excluded from this series those cases where mediastinal or abdominal glandular enlargement was the first sign found. Thus we con-:clude that many cases of ultimately fatal disease might be saved by a more careful, earlier, and more vigorous treatment of the enlarged glands. Through-:out the greater part of the Profession there seems to be a lamentable ignorance of the anatomy and physiology of the lymphatic system. The intercommunications of groups of glands are little studied, but a know-:ledge of them would be a great help in predicting the various possible routes infection might take. Again, it is not sufficient to diagnose tuberculous adenitis, but in every case a thorough search should be made for the portal of entrance of the infection. In such cases, I employ and would recommend the following routine: Examine (1) the teeth for caries and root abscesses/

abscesses; (2) the lips, gums and tongue for stomatit-:is or traumatic and other ulcers, (3) the tonsils, (4) the posterior and anterior nares, and naso-pharynx, (5) the head for pediculus capitis, (6) the face and head for impetigo-contagiosa, paying special attention to all angles and folds of skin, as at the ear and mouth. In the case of glands elsewhere than in the neck, search has to be made for pediculosis, impetigo, scabies, and other causes of itching in other parts of the body.

PHYSICAL DIAGNOSIS.

Inspection.

Much may always be learned of the internal parts of the body by a careful consideration of the exterior. The first point to note is the general build and conformity of the individual. Flattening of the chest; elevation of one shoulder; bulging of the abdomen; local wasting or spasm of groups of muscles; spinal curvature, especially scoliosis; are all of some value. Next the skin and hair should be looked at. I have observed in children affected with tuberculosis two types of skin (a) the "transpar-:ent" delicate type, through which the venules are easily seen, and which imparts to the hand a sensation of/

of smoothness as if it were waxed, and (b) the dry, harsh type, which looks and feels rough. The colour varies also, but generally a pallor exists, often with marked redness of the cheeks. This flush, when more marked on one side than on the other, may be of special significance.

The hair in children affected is generally profuse, often coarse and hard, but sometimes very fine and silky. It has been said that red haired children are more often affected than others, but, although I have frequently observed the disease with those in red hair, I could not attach any importance to the feature for the proportion seems no higher than in the case of other colours. The eyebrows are usually plentiful, and the lashes long and slightly curved.

The tongue is usually furred and generally red at the edges, - almost "raw" indeed. Careful palpation should be made at the angles of the jaw and the supra-clavicular regions for enlargement of glands. The enlargement is often not great, but is common in children, the first indicating infection through the tonsils and naso pharynx, the latter, an apical lesion.

Percussion.

In the early stages, percussion may yield negative/

negative results, except in so far as alterations in the note indicate enlarged mediastinal glands as already noted. At the same time, - and this is more true of children than of adults, - very light percuss-:ion may, even in incipient cases, demonstrate an altered note. The alteration is mostly in the pitch which is often higher than in health.

Auscultation.

Auscultation is a very much more delicate test. There are two things to be specially noted, (1) the character of the breath sounds, and (2) the presence or absence of adventitious sounds. In regard to the character of the sounds, it has to be remembered that they are not quite the same in chil-:dren as in adults. The note is harsher and higher-pitched, while the expiratory murmur is longer, - the so-called puerile type. The changes produced in the more advanced disease are easy of recognition, but the matter is far different in early cases.

The first change found as a rule, is loss of the soft character of the murmur, and substitution for it of a rough, harsh sound, especially in inspiration. Next to this, comes weakness or feebleness of the sound. While the first of these departures from normal/

normal is generally confined to the area of the disease, the second is not, and may occur throughout one side. The cog-wheel type of respiration is of no value in children, but broncho-vesicular and vesiculo-bronchial types are important. By broncho,vesicular breathing is meant a respiratory murmur, when inspiration is harsh and bronchial, while expiration is vesicular but the same length as inspiration, and by vesiculo-bronch-:ial, the type in which inspiration is vesicular and expiration bronchial. These indicate a slightly more advanced disease, but when found at the right apex, are valueless, because almost normally present there.

These fine gradations of sound are rather difficult of detection, and somewhat more so in children than in adults, firstly because the normal sounds are different, and secondly, because children often exhibit physical signs out of all proportion to the extent of the lesion.

The adventitious sounds produced in early disease have to be sought for with great care. Naturally, they are only of value where the case is not one of tuberculosis supervening on bronchitis. Care-:ful exploration of the chest may elicit, where no other physical signs exist, fine crepitations in the second half of inspiration. This is a very characteris-:tic sign in children, indicating slight congestion due

to/

to the deposition of one or two small tubercles. When the case is slightly more advanced, subcrepitant rales are heard. These are short, sharp crackling sounds, coarser than crepitations.

Two other very important things may be found on auscultation viz., loud conduction of heart sounds over a larger area than usual, and friction along the lower edge of the scapula, when the patient's hand is placed on the opposite shoulder. This indicates interlobar pleurisy and is often a precursor of pulmon-:ary tuberculosis.

Sputum Examination.

It is generally regarded as very difficult to get a sample of sputum from a child for purposes of bacteriological examination, because the expectoration is swallowed. Dr. Holt for this purpose recommends irritating the back of the pharnyx with a piece of muslin held in artery forceps. Cough is thus excited and the sputum is caught on the muslin. The presence of the tubercle bacillus in the sputum is very valuable and definite evidence of tuberculosis, but its absence by no means proves the opposite, for the organism frequently, both in children and adults, appears quite late in the spit. Nevertheless this part of the examination should on no account be omitted.

SCHEME OF EXAMINATION.

We may now formulate a scheme of examination based on what has been said of physical signs and symptoms. The child presented for examination, will be accompanied by a responsible person, cognisant of its history, habits, and family.

A. Firstly, a full note of the complaint will be taken, followed by a searching inquiry into the family-history, and personal history. The points to be specially emphasised in these notes, so far as the question of tuberculous infection is concerned, are:-

1. In the complaint:- Lassitude; lack of interest in childish pursuits; cough; loss of appetite; loss of weight; pain; diarrhoea; dyspepsia; and in a lesser degree, sweating at night and haemophysis; and distension of abdomen.

2. In the personal history:- Swelling of glands; measles; whooping-cough; bronchitis; asthma; pleurisy; empyema; emphysema; pneumonia; indefinite pyretic attacks; pain or swelling of joints; impetigo; lupus; tonsillitis; pediculosis; phlyctenular ophthalmia.

3. In the family-history:- phthisis; tuberculosis of glands; bones, joints, meninges, bowel or skin; asthma/

asthma; bronchitis; emphysema; general weakness. Considerable time and care require to be spent on these investigations before the examination proper is commenced.

B. For examination the patient should be completely stripped and placed in a good light, preferably standing in the first instance. The physician, standing about one yard to five feet away, will then scan the whole body with scrupulous care, and at this stage, should not touch the patient with his hands. In the course of this scrutiny the following points have to be noted:- the condition of skin, hair, eyebrows, eyelashes, nails, pupils; the colour; the presence or absence of muscular wasting general or local; evidence of localised muscular spasm; the poise and symmetry of the body; the nature of the thoracic movements in respiration; sweating, especially from the axillae; prominence of the abdomen; the apex impulse; the type of breathing i.e., by nose or mouth; nasal discharge; local swellings; and the appearance of the protruded tongue.

This examination requires to be systematically carried out, and the best way is probably to start at the crown of the head and work downwards. The time occupied is well spent, and this opportunity may be taken/

taken to become acquainted with the child and dispel any fear that may exist.

C. Then, and only then, is it permissible to lay a hand upon the child. The hand is a useful member, but a distinction has to be drawn between "feeling" a patient, and "palpating" a patient. Our hands derive information in two ways, (1) by the superficial, tactile, epicritic sense, and (2) by the deep "muscle-joint" sense. By running the hand lightly over the body, much may be learned from the tactile sensation. We wish to know (1) the state of the skin from the point of view of its dryness, its roughness, the sensation of "waxiness", its heat, (11) the nature of the hair, whether soft and silky or brittle and dry.

These points ascertained, systematic palpation has to be employed. Again it is well to commence at the head. In the first place, one hand should be used on either side of the body, and every group of muscles felt in turn. Wasting and spasm not apparent to the eye, can be made out by comparing the two sides, for a muscle, ere it loses substance loses tone, and this loss can be felt. Next, a search has to be made for glands, due regard being paid to the likely and more important places, viz: the angle/

angle of the jaw, the anterior and posterior cervical groups, the supraclavicular, and top of the mediastin-:al. The patient now being placed on his back, a thorough palpation of the abdomen is made, while all joints are tested for limitation of movement, pain, and tenderness.

Localising Methods.

A general survey of the body has now been made with a view to finding evidence of tuberculosis, and the next steps are confined to searching for pul-:monary lesions. In the first place the physical signs mentioned in connection with enlargement of mediastinal glands should be looked for, whereafter a careful examination of the thorax by percussion, pal-:pation and auscultation, must be made. Palpation is reintroduced here, because in the examination of the chest, vocal fremitus has to be tested, this being done by laying the hand flat on the chest, and causing the patient first to articulate, then to whisper syllables containing "n", - as "ninety-nine." In an advanced case percussion will at once reveal alteration in lung-tissue, but here we are dealing with early, suspected or contact cases in addition to patients not suspect, - as school-children under-:going routine examination by school medical officers.

Both/

Both in percussion and auscultation, what we have to look for are those finer gradations of sounds, those very min-:ute departures from the normal, already detailed. The chest, back and front, must be gone over inch by inch, finger's breadth by finger's breadth.

The results of such examination are best grap-:hically represented upon a chart depicting the outline of the body, with the ribs sketched in, one showing the anterior, the other the posterior aspects of the body. Impairment of percussion note may be represented by parallel lines, which, when placed far apart will indic-:ate slight impairment, ——— when closer together ═══ relative dullness, and when almost meeting absolute dullness ▬▬ .

In noting the results of auscultation we have to take into consideration both the breath-sounds - R.M.- and the accompaniaments. The following are convenient symbols:-

After Crocket:

 Vesicular Respiratory murmur.

 Roughened vesicular R.M.

 Puerile R.M.

 Vesicular R.M. with prolonged expiration.

 Cogwhell breathing.

 Broncho-vesicular breathing.

 Vesiculo-bronchial breathing.

 Metamorphic breathing.

Bronchial/

 Bronchial breathing.

 Cavernous or tubular breathing.

 Amorphic breathing.

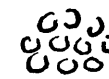
Diagonal lines may be used to indicate weakened respir-:ation, one / meaning slight diminution; two // more marked; three /// very marked; and four //// suppression.

The adventitious sounds may be conveniently represented as follows:-

 Fine crepitations

 Subcrepitant rales.

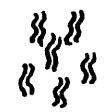
 Mucous rales

 Cavernous rales

 Sibilant rhonchi

 Sonorour rhonchi

 Fine pleuritic friction

 Coarse pleuritic friction.

In addition it is well to note briefly in words the findings, as "Slight impairment of percussion note right apex; harsh R.M. right apex and left lower lobe below scapula behind; Fine crepitations right apex, otherwise no accompaniments; No increase vocal fremitus or vocal resonance." Such brief notes assist in making clearer the meaning of the diagram.

The physical examination is not completed until certain other parts have been considered. These are: the tonsils, teeth, nasopharynx, anterior and posterior/

posterior nases, larynx and funfus oculorum. Carious teeth are a positive danger, and so are enlarged, or small foul tonsils, adenoid vegetations, enlarged tur-:binates, and sinusitis. As elsewhere noted, the presence of any or all of these does not indicate early tuberculosis, and in none of them is primary tuberculous infection the cause of disease with sufficient frequency to be of importance. They all, however, as it were fertilise the soil for the germination of the seed of tubercle.

It has also been said that the larynx is rare-:ly the seat of primary disease. Nevertheless the presence of tuberculosis of the larynx may be a very early danger signal, and the examination should never be omitted. In addition, laryngeal examination may suffice to establish the nature of an obscure pulmonary condition, and often will be a great aid in prognosis.

The lesions exist in three stages:- (1) de-:posit and catarrh, (2) ulceration and proliferation, (3) perichondritis. The earliest physical sign,, as a rule, is anaemia, - sometimes hyperaemia, - of larynx and palate, while localised hyperaemia or catarrh, are very suggestive, and rounding or loss of lustre of a cord, and paresis of adductor muscles, would give rise to suspicion. In a series of children under fifteen years/

years examined, where early tuberculosis was present or suspected, I found symptoms of laryngitis in five percent, and definite suggestive physical signs in the larynx in fifteen percent, though, in this series, no case showed advanced laryngeal lesions.

CONFIRMATORY SPECIAL METHODS.

Only when the whole of this examination has been carried out, is it permissible to turn to special tests. Tuberculin has already been referred to but the methods of application might be more fully considered here.

A. Von Pirquet's cutaneous test. The technique of this test is very simple:- The site of application is first cleansed with soap and water, then with ether: In the words of Von Pirquet (Journal of the American Medical Association, Feb.27, 1909,page 675): "My method of applying the test is as follows: The skin of the forearm is scrubbed with ether, then two drops of undiluted old tuberculin are dropped about four inches distant from each other. Then, with a vaccinating lancet, the point of which has the form of a small chisel, a superficial scarification is made between the two drops, (for the control of the traumatic redness following the small scarification). Finally/

Finally the same scarification is made inside the two drops; a few fibres of cotton are put upon the drops so that they will not flow. After five minutes the cotton is taken off. No dressing is applied. The papule is examined after twenty-four and forty-eight hours. It is considered as positive when the tuber-:culin scarifications are clearly different from the control places, but the inflammatory reactive area must measure at least one fifth of an inch."

The best site for testing is the inner side of the forearm, because here the skin is relatively delicate, and is free from hairs. No other disinfect-:ant than ether should be used. The scarifie recom-:mended by Von Pirquet is a chisel-shaped point about 1/16 inch in width, which is held vertical to the skin and rotated. The amount of the abrasion should be such that the control spot shows a scab the next day, but blood should not be drawn.

If only one subsequent inspection of the result is possible, the best time for it is after forty-eight hours, but, if possible, inspection should be made after twenty-four and forty-eight hours, and then after three, four, and eight days. A negative reaction will be closely similar to the traumatic reaction arising from the control scarification. The positive/

positive reaction appears generally under twenty-four hours, and is at its maximum after forty-eight, though its appearance may be delayed for several days. It begins as a slightly raised, red spot, spreading outward from the scarification and quickly increasing in extent and height. The diameter is usually about 10 mm., but, in exceptional cases, may extend to as much as 30 mm. The edge of the papule is round or irregular, sometimes showing long spurs along the lymph vessels, while in some cases the margin is obscured by ill-defined follicle-like swellings. Reactions showing such knob-like swellings in the region of the papule, were noted by Von Pirquet in scrofulous children, and they rather resemble the appearances of lichen scrofulosus. In very intense results a red halo surrounds the reaction in some instances.

After about forty-eight hours the redness fades, passing through violet and yellow to a pigmenta-:tion which may remain for many weeks. The swelling disappears and scaling of the epidermis sometimes occurs. Although this is the usual type of reaction, there are many variations. Thus, the appearance of the reaction is sometimes delayed for several days, this, according to Von Pirquet occurring mostly in unsuspected cases. Occasionally there is no hyperaemia and the presence of the reaction can only be detected by touch. Von

pirquet/

Pirquet called this the "Cachectic reaction" since it occurred only in late cases, and indicated the inability of the skin to react. When revaccination produces a reaction where none occurred with the first, the patient is generally a child in whom tubercle cannot be clinic-:ally demonstrated.

B. Calmette's conjunctival test:- The technique of this test is equally simple. A one percent, or half percent solution is used. The eye to be examined should be ascertained to be in every respect sound. For the instillation, a drop pipette is the best instrument to use. With the patient seated and his head inclined backwards, the operator should, with the thumb of his left hand slightly retract tne lower eyelid. The pipette is held in his right hand, but he should now bring the nozzle of it close to the eye, but not in contact with it, near the inner angle. Gentle press-:ure on the bulb will cause a drop to fall into the con-:junctival sac. The lid should be held retracted for some seconds so that the drop will diffuse over the con-:junctiva, and the patient should continue to look up for sometime. These precautions are taken to prevent the drop being expelled from the eye. Three grades of positive reaction are distinguished.

Grade 1:- Reddening of the caruncle and palpebral conjunctiva/

conjunctiva.

Grade 2.+ Intenser redness, with involvement of the ocular conjunctiva, swelling and increased secretion.

Grade 3.+ Intense reddening of the whole conjunctiva, severe chemosis, much fibrinous and purulent secretion and small ecchymoses. The opposite eye is used as a control.

Where a negative result is found at first the test is repeated on the other eye. This test is not without danger, for, apart from the discomfort of a conjuncticitis, permanent damage may be done to the eye, and at any future time a recrudescence of reaction may occur even when the cutaneous method is employed. Furthermore, the test if contraindicated in young chil-:dren and scrofula.

C. Moro's Percutaneous Test. The method of prepar-:ing Moro's Tuberculin Ointment has elsewhere been con-:sidered. Results have been good, surgical tubercul-:osis generally yielding a severe reaction; scrofula a mild one; pulmonary disease a well-marked one; and miliary and meningeal tuberculosis none. A disadvan-:tage of the method is that severe irritation which sometimes spreads to other parts of the body, producing at times a small exanthema, is apt to be produced.

D./

D. Subcutaneous Tuberculin Reaction. This is somewhat elaborate and opinions are rather varied as to the best method of application. Koch's old tuberculin is used, though some observers recommend Koch's albumose-free tuberculin, since the general reactions with it are inclined to be milder. The tuberculin is diluted with ½ percent phenol solution, and the dilutions stored in sterile test-tubes closed with a cotton-wool plug, or in wide-necked glass-stoppered bottles. Convenient dilutions are 1 in 10; 1 in 20; 1 in 100; 1 in 1000; in which the dose will be respectively 10 c.mm; 5 c mm.; 1·0 c.mm.; and 0·1 c.mm. tuberculin. In weakly subjects it is well to start with a dose of 0·1 c.mm., though 0·2 c.mm. is frequently used.

Prior to the inoculation the part should be rubbed with ether. The arm is frequently used, but the back below the level of the shoulder blades, is held to be the best site. The time of the injection is important, because reactions may set in and pass away rather quickly, - within a few hours. To permit of sufficient observation of the results, it is best to make the injection in the early hours of the forenoon. The normal daily range of the patient's temperature must be known, and, if it is elevated at any time of the day, the test has to be withheld until this is

overcome/

overcome.

The initial dose should be small, and a substantial difference should exist between the quantity of each successive injection, and at least forty-eight hours should be allowed to elapse between them. At the same time, the dose must only be increased when the previous one has caused no rise of temperature. In children suitable doses are, (1) 0·1 c. mm., (2) 0·5 c.mm., (3) 2·5 c.mm., (4) 5 c.mm.

The reaction:- This is three-fold:- a. local, b. general, c. focal. Thus, the tuberculin attacks the diseased focus direct and in this respect differs materially from the cutaneous reactions. The local reaction consists of inflammation at the site of injection; the focal of inflammation at the focus of disease; and the general reaction, of (1) rise of temperature, and (2) disturbance of physical well-being.

These reactions will now be considered seriatim.

The General Reaction:-

Fever. An elevation of temperature is the most constant feature of the reaction. A rise of 1 ^{o}F or more beyond the previous maximum for the individual, is considered a positive reaction, and the amount of the increase/

increase permits of a differentiation into slight, mod-:erate, and severe. The most common type is a rapid rise and more gradual fall, normal being reached in twenty-four hours or slightly more, the rise commencing in six to eight hours from the time of the injection though it may occur sooner, or, occasionally, not for about 30 hours, while the maximum is most often reached in about nine hours. If the rise is small, repetit-:ion of a similar dose will often produce a very con-:siderable rise, while rises due to intercurrent infammatory states or a nervous constitution must be excluded.

General Disturbances. At first, a rigor, followed by a sensation of warmth, or a feeling of chilliness, with giddiness, nausea, or vomiting are the common symptoms. These are followed by headache, loss of appetite, general malaise, thirst, lassitude, sleeplessness, palpitation, pains in the limbs, and stabbing pain in the affected organ. As the temperature falls, a sen-:sation of weakness is experienced, this gradually passing off with the return to normal. Great varia-:tions are found in different individuals, and the severity of symptoms cannot be regarded as an index of the activity or extent of the disease

Local/

Local Reaction:

Generally more or less severe swelling and pain are produced at the site of injection.

Focal Reaction:

By this reaction a clue is obtained to the situation of the disease. The symptoms found depend upon the structure and function of the organ affected, and are, accordingly, many and varied.

Relative Value of the Tests.

With four methods from which to choose it is important that we should determine what is of most general application, and of greatest service in diagnosis. Those points having been established, it is best for the practitioner to stick to one test, with the various types of reaction of which, he will thus become familiar, and it will in his hands, then be of greater value. For ease of application the Von Pirquet reaction is certainly to be commended. It possesses few contra-indications and, such as there are have little importance. The test is specific, and is of greater value the younger the child to be examined. The fallacies and false results are not many; the method may be used by a doctor in his consulting room; and there is no general disturbance. Moro's reaction possesses no

greater/

greater advantages, is not quite so easy of application and interpretation, and has the disadvantage that it is less sensitive. Calmette's reaction is contraindicated in children, and should never be used in them.

In my experience I have found Von Pirquet's reaction very reliable. I have never used the Ophthal-:mo reaction in children but in observations upon adults, I have found the results so misleading that I decided not to employ the method at all. In regard to Moro's re-:action, although it could on occasion be employed with-:our arousing suspicion and fear in the minds of patients and their friends, I found that the irritation caused in some cases outweighed this advantage, and the rather greater uncertainty of the results made it far inferior to Von Pirquet's. On older children I never use the percutaneous method, although in infants under eighteen months or two years, I frequently employ it.

My conclusion, both from my own cases, and from the writing of authorities, is that Von Pirquet's method is the test "par excellence" for children.

The subcutaneous method is in an entirely differ-:ent plane from these three. The dosage is more exact, the results more striking. The preparation of the patient, however, is elaborate, and the general distur-:bance considerable, so that the method can scarcely be employed by a physician in his consulting room. Of all/

all the tests it is the only one that gives any indication of the situation of the lesion, and this is, of course, a great advantage. At the same time, for children it is scarcely to be recommended as the method of choice, be-:cause its application is, though only slightly painful, rather terrifying, and the results are somewhat out of proportion to its value. It is a test that can always be used as a final court of appeal, and thus I employ it. In short, as the routine measure, I use Von Pirquet's test substituting Moro's in young infants and very nervous children, and if any doubt then remains, apply the cutaneous reaction.

RADIOGRAPHY.

By the examination that has now been done it will have been established, with some degree of certain-:ty, whether there is tuberculosis present, and now the main thing is to determine the exact situation and the extent of the lesion. Of all the newer methods of diagnosis there is none that has shed so much light on tuberculosis in its early stages as the X-rays. This method must not be used as the first, the sole, or principal diagnostic measure, but to confirm a diagnosis, to settle a doubt, to localise and delimit the disease it is of the utmost value.

In the early days of Rontgen examination, only

the/

the skeletal elements of the body were believed to be made clear by the rays, but subsequently it has been found that even the soft parts and organs can be examined in this way. Of course, in disease of the bones and joints the X-rays will be the main deciding factor, capable of establishing the nature of the disability before marked symptoms develop. Vague pains and a feeling of tiredness in the limb are generally the first complaints; and limitation of movement, a decided limp etc. come later. A radiograph will, in most cases, demonstrate the lesion from the very first.

In intra-abdominal tuberculosis, the X-rays again may prove of great use. There will not be so clear a differentiation of the diseased and the healthy parts as in the case of bones and joints, but the expert can read a film as another man will read a page of print, and a very slight departure from normal can be noted. Thus, a cloudiness of a part of the film may indicate pus or a condensation of the tissues, while adhesions and calcified glands will show quite clearly. No claim can be made that radiography will, in abdominal tuberculosis, establish the diagnosis early, for the disease is fairly well advanced before those changes occur which the X-rays can distinguish, but it may assist greatly in making clear an obscure case, and may

prove/

prove of value in making a prognosis and determining the extent of the diseased condition, and, therefore, the treatment.

There is much difference of opinion regarding the value of X-rays in thoracic conditions, some authors maintaining that they give no more information than a good physical examination, while others find them most useful in assisting towards an early diagnosis. In the hands of the physical diagnostician they are possibly of more use than in those of the radiologist, for every film should be read not as a unit in itself, but as part of a complete picture. Our aim in a physical examination is to visualise what is going on inside the skeletal walls. If we look at our X-ray films by themselves, we are but viewing one isolated part of a complicated jig-saw puzzle, whereas , what we wish is to see the thing as a whole, with every piece in its place. In this way, foci of disease which otherwise might have passed unnoticed, especially enlargement of peribronchial glands, and infiltrations round the bronchi, will be brought to light.

The healthy lung offers but little resistance to the passage of X-rays, and appears as no more than a faint uniform shadow with clearly defined edges. The very earliest local changes brought about by the tubercle bacillus will cause no alteration in the shadow/

shadow, for this will only occur when sufficient infiltration has occurred to affect the passage of the rays. At such an early stage physical signs are very vague and altogether indefinite, though symptoms may be well marked; but a local increase in the intensity of the shadow, however slight, in conjunction with these symptoms, is quite enough to establish a diagnosis.

It has previously been seen that tuberculosis by no means always exists alone, but may frequently be a complication of, or be complicated by bronchitis, asthma, emphysema, and so on. Any such condition greatly increases the difficulties of diagnosis, for the physical signs of tuberculosis are marked by those of the interucrrent disease. Under such circumstances the X-ray stands without rival as a diagnostic method. In children especially, the commonest situation for the disease to commence, is at the hilus, and this is the very place where physical signs are hard to find. But the X-rays will penetrate to this area and show quite minute departures from the normal.

We can distinguish three classes of cases of early tuberculosis:-

1. Those in which X-rays will demonstrate lesions before they can be detected by physical examination.
2. Those in which X-rays will only confirm what physical examination reveals.

3./

3. Those in which X-rays fail to show what causes the physical signs found by percussion and auscultation.

We can expect from X-ray examination, therefore, the following results:-

(1) Confirmation of the results of other methods of diagnosis, and establishment of the form, position and movements of the various organs.

(2) A fuller and more exact knowledge of the thoracic structures especially as regards the hila, perebronchial and para-tracheal structures.

(3) Differential diagnosis of conditions found by physical examination, e.g. presence of fluid, aneurysm, neoplasm, disease in the mediastinum.

(4) Permanent records of progress.

The complete examination should include:-

a. Viewing with the fluorescent screen.

b. Radiography or the taking of films, which should include:- (1) an anterior view, (11) posterior view, (111) the apices, (1V) oblique views, - right and left.

The changes must usually found, will next be considered. The importance of systematic examinations has elsewhere been emphasised, and the consideration of an X-ray film is no exception to the rule. The best order of examination, I think, is that followed by Dr. Crocket, viz:-

1./

1. The general orientation of the bony structure.
2. The heart.
3. The upper mediastinum and the hilus.
4. The apices.
5. The body of the lung from the second rib to the base.
6. The diaphragm.

In tuberculosis, changes may be found in any or all of these.

(1) The position of the ribs, and the comparison of the two sides are important. In children the ribs are soft, and readily moulded, so that increased or deceased obliquity, localised bulging, and any difference of the two sides, may shed light upon the state of affairs within.

(2) The size, position, and density of the cardiac shadow are the special points to note in regard to the heart. In early and acute cases the shadow is fainter, and in old cases, the shadow may be more dense, and the position altered.

(3) The mediastinum and hila, are the most important places in children. Tuberculous mediastinitis is the cause of a very large proportion of those cases of lethargy and indefinable ill health several times referred to, and, though the presence of some of the physical signs noted may give grounds for suspicion, the ultimate diagnosis depends very largely upon the X-rays. With the enlarged glands and periadenitis produced, we are apt to get a broad shadow/

shadow, overlapping that of the sternum and aorta. The hilus in health extends from the second to the four-:th corto-sternal junctions in front on either side, and the fourth to the sixth dosral spines behind. It is crescentic and does not extend beyond the boney extrem-:ity of the ribs. In children there should be pract-:ically no shadow at all. In disease the shadows become more marked, with indefinite boundaries in early and acute cases, and well-marked margins in chronic. From them, shadows may radiate to other parts of the lung.

(4) The Apices: In health, in children, the apices are quite clear, and the slightest suspicion of shadow is evidence of disease. At the same time, disease of supra-clavicular glands will be shown in this area, and, though in itself important, this must be distinguished from actual infiltration of the apex.

(5) The body of the lungs from the second rib to the base: A mottling here and there indicates local infiltration, a dense shadow, extending from the base upwards means fluid, while linear shadows radiating from the roots, point to thickened peribronchial lymphatics. Throughout, small dense areas may be found corresponding to calcified glands, or tuberculous foci, while cavities are known by the excessively clear areas/

areas they yield.

6. The diaphragm:

The information desired in connection with the diaphragm is:- (a) the form and contour, (b) the extent and character of the movement. Effusion will materially alter form and contour, while in quite early disease the diaphragmatic excursion is lessened, and often in tuberculosis the movement becomes jerky.

Thus, while in common with all other means of examination at our disposal, radioscopy and radiography must not be taken separately as a supplement to other methods their value can scarcely be over-estimated. At any rate, no examination of a suspected child is complete until an investigation by means of the X-rays has been carried out.

REGIONAL DIAGNOSIS:-

1. Intrathoracic Glands.

The glands with which we are here concerned, are situated in the bifurcation of the trachea and al-:ong the main bronchi, and number about twelve to fif-:teen. Smaller glands lie along the bronchi as they pass into the lungs, in the interlobular/connective tissue. They are/

are supplied by the peribronchial, subpleural, and perivascular lymphatics. They may be readily infect-:ed from the abdomen and retroperitonial tissues and the posterior mediastinum, while in some instances infection comes from the tonsil via the cervical glands. In adults, any disease of these glands is, as a rule, secondary to disease of the lungs, but in children the case is very different. Until the age of ten years is reached infection is generally by ingestion, and the intrathoracic glands become involved from the abdomen, so that extensive disease may exist in them when the lungs are clear, or practically so.

When well-marked, such enlargement gives rise to various subjective symptoms, chief amongst which is cough. Obviously the cough is caused, mainly or solely, by irritation, and accordingly, it is dry and hard, frequently spasmodic or paroxysmal. As a result of pressure on the vagus nerve or the recurrent larnygeal nerves, spasm of the adductor muscles of the larynx or paralysis of the abductors may occur, with cough, dyspepsia, and hoarseness, while the last named may also be produced by pressure on trachea or bronchi. The character of the heart-beat may be altered by pressure on the vagus. If the disease is at all extensive there will be loss of weight and loss of

appetite/

appetite, while the child will run an irregular temper-:ature. Pain is frequently complained of and is gen-:erally referred to the fourth or fifth dorsal vertebrae behind or to the upper part of the sternum, while a cer-:tain amount of haemoptysis may occur.

The physical diagnosis is far from easy. Dullness may be found in the interscapular region, accompanied by bronchial breathing and increase of vocal resonance. Owing to pressure on bronchi, the breath sounds may be feeble over either or both lungs or over one lobe, with compensatory emphysema character-:ised by hyper-resonance, over the other parts. The heart may be displaced and its sounds widely conducted The sign of Eustace Smith, viz: a purring sound heard by placing the stethoscope below the suprasternal notch when the child puts the head backwards, is by some held to be pathognomonic.

Examination by the X-rays will, in most cases, clinch the diagnosis. By this means dark shadows, often with a blurred outline, will indicate the enlarged glands; and local constriction of the bronchi or displacement of the heart will also be seen.

These grandular enlargements are of great importance, for they are apt to terminate in one of two things:- (1) spread by direct extension to adjacent parts/

parts of the lung and thence to the apex, or (2) miliary tuberculosis. In the case of extension to the lung the symptoms become more severe and the usual physical signs are found in the lung commencing with slight impairment of the percussion note, and fine crepitations. When miliary tuberculosis occurs the change in physical signs is not perceptible, but the general symptoms become much more severe and increase until death supervenes.

The following case illustrates the great importance of tuberculosis of these glands:-
J.C. aged 12 years, suffered from cervical adenitis. A small mass of glands was removed and he remained for some months quite well. After an interval of eight months I was consulted regarding hoarseness and slight cough. The larynx showed no departure from normal, and after a searching examination I diagnosed peri-:bronchial adenitis which was confirmed by X-rays. The boy was sent to hospital and for a time did well, and then began to lose flesh; cough and spit increased, and night sweats were severe. A lesion was found in his right apex and this gradually progressed. Four months after admission, he complained of abdominal pain, and ascites developed. This cleared up in about three months, and for four weeks he seemed to gain ground, until, without warning, tuberculous meningitis/

meningitis supervened and he died in ten days.

2. Tuberculous Meningitis.

This condition, which is most common in young children and is almost invariably fatal, is in its early stages not easy to diagnose. In the majority of cases the onset is insidious. The child does not look ill, and yet shows every sign of feeling so. A common mode of onset is with sickness and vomiting, while may last a variable length of time before definite symptoms are found. When well-developed the head is retracted, the abdomen drawn in, - "scaphoid", - optic-neuritis is found, strabismus developes, and Kernig's sign may be elicited. Only an examination of the cerebro-spinal fluid will finally settle the diagnosis. Lymphocytes and tubercle bacilli are the special features. The difficulty of diagnosis is well illustrated by the following two cases of girls of exactly the same age, namely, two years.

a. J.W. had complained for three days of tiredness, and had vomited all the food ingested. On examination, her temperature was 99 ^{o}F, her pulse 100, the tongue slightly furred. The abdomen was quite lax, and no tumour could be felt, nor tenderness elicited. The reflexes were normal; no Kernig's sign nor nuchal rigidity/

rigidity could be found; the pupillary reactions were un-:altered and the fundi were normal. Yet the child seem-:ed ill and moaned incessantly, though she lay unnaturally still in the bed and paid no attention to anything that was going on. On lumbar puncture increase of pressure of the cerebro spinal fluid was noted, the lymphocytes were found but no bacilli. For three days the condition remained unchanged, except that the child took less and less interest in her surroundings. On the fourth day, for the first time, the abdomen assumed a scaphoid shape, head-retraction was found, and Kernig's sign was elicited, while the fundi showed optic neuritis, but no choroid tubercles. On the seventh day a marked external strab-:ismus developed, and the child died on the eleventh day.

b. M.G.'s illness started with alarming suddenness. For two days she had been mildly out of sorts and for a week had had slight diarrhoea, when, about 1 a.m. she had what the relatives termed a convulsion. By the time I saw her the "convulsion" had passed, and she was lying quite still. She paid no attention to sharp noises, but lay on her side with her head drawn back, and when she was touched she uttered a sharp cry. Lumbar puncture revealed lymphocytes and tubercle bacilli in the cerebro-spinal fluid. Two days later, optic neuritis and external strabismus were noted, and on the fifth day she died.

It/

It is very questionable if an earlier diag-:nosis of tuberculous meningitis would affect the pro-:gnosis, but this disease is generally a manifestation of miliary tuberculosis, so that much depends upon the detection of the very earliest evidence of tuberculous deposits in glands in any part of the body, and of course, these cannot be detected until the child is brought under the doctor's notice. It is therefore imperative that people should be educated to under-:stand that, for the slightly ailing child, not the next-door neighbour, but the family physician is the person to pronounce judgment.

3. Surgical Tuberculosis:

a. Bones and Joints.

Tuberculosis of bones, joints, and skin are generally relatively easy to diagnose. One sometimes hears the word "primary" applied to a lesion in bone or joint, but such lesions are never primary, but con-:stitute a single part of a general infection. In-:fection reaches them through the blood, and may become deposited to begin with:- (1) in the arterioles, or (2) in the venous terminals.

In the case of infection by way of the arterioles, a wedge-shaped infaret is produced, as a rule with its base towards the articular surface.

Where/

Where the venous terminals are the settling place, the deposit generally occurs upon the articular side of the epiphyseal cartilage.

In either case the deposit may remain quiescent for a long time, and then from some cause, e.g. trauma, light up into an active focus. As young bones are more liable to trauma than older ones, tuberculosis of bones and joints is more common in children.

One of the first clinical manifestations is muscular spasm. Pain may or may not be present, and may be referred to some other part. Next come limitation of movement and swelling, with the development of characteristic postures. Night-startings are common, and give a clue to the cause of the condition. Pain is probably more frequent than is generally supposed, and a thorough investigation would, in many cases, establish the diagnosis as tuberculosis, and not "growing pains" or the equally vague "rheumatism."

Three stages can be distinguished:

a. Hydrops, when the synovial membrane is inflamed and exudation occurs.

b. "White swelling" when the cartilage is invaded.

c. Tuberculous suppurative arthritis.

It is most important that the disease should be recognised early, for success in treatment depends/

depends largely upon an early start of drastic measures.

When a limb or joint is complained of in a child, I use the following routine in the hope of being able to detect the earliest signs of tuberculous disease:

1. The child is stripped and lies on his back, with the two corresponding limbs in absolutely identical positi-:ons. The usual inspection of skin etc. is carried out, and wasting is looked for. Then the length of the two limbs is measured, and the circumference, at the suspected joint and round the groups of muscles attached thereto. These muscles are also carefully palpated for spasm or "flabbiness."

2. The limb is thoroughly tested for limitation of move-:ment. Now, in early cases, limitation of movement is brought about entirely by muscular action, and it is important as each movement is tested, that the hand should so grasp the limb that any sudden spasmodic contraction of muscles will be distinguished by it. Just as, in testing the knee-jerk a hand placed on the thigh can feel the muscular contraction when the lower limb does not move, so a "guarding" contraction of muscles can be felt when insufficient to affect the passive movement of the limb.

3. The suspected joint is next examined by the X-rays, and I prefer to have five films, (a) from the front, (b) from behind, (c) from one side, (d) from the other side/

side, (e) side by side with the other limb. In early cases all that is shown may be a want of definition of the joint capsule and a haziness of the articular sur-:faces, but if the case is more advanced a clearer area in the bone near the epiphyseal plate indicates a focus of disease undergoing caseation, while a dark shadow means sclerosis. An appearance frequently seen is a marked rarity of the bone on the affected side as com-:pared with the other, even the diaphysys giving a paler shadow.

4. If the slightest doubt remains, tuberculin tests are carried out, either Von Pirquet's or the subcutaneous being the reaction chosen. In regard to the latter, the focal reaction in such cases is frequently of value.

b. Skin.

Tuberculosis of the skin is not always easy to diagnose, by reason of its varying manifestations. The following are the principal:

1. Lichen scrofulosus, a papular eruption, the papules seldom being larger than a pin's head, flattened, and red in colour. The summit is marked by a scale or small pustule, and they are arranged generally in groups. The commonest site is the lower abdomen or the back. There is neither pain nor itching. This disease is frequently/

frequently accompanied by enlarged glands or other ev-:idence of tuberculosis, and the patient is very rarely over twenty years of age.

2. Scrofulous ulcers, which may arise; (a) by extension from caseating glands, (b) by breaking down of a sub-:cutaneous nodule, (c) by extension from bone. The edges of these ulcers are frequently thin, ragged, and undermined; the floor is irregular and grey, covered with flabby granulations and foul pus.

3. Primary tuberculous ulcers may develop in almost any part of the body, generally from the breaking down of a tuberculous node. The edges are ragged, infiltrated and undermined; the floor is indurated and covered with yellow nodules, with a thin and watery discharge. The surface is often crusted, and considerable pain is sometimes present.

4. Post-mortem wart, (Verruca Necrogenica) is of no importance in children.

5. Erythema Induratum (Bazin's disease) on the other hand is very important. To begin with, deep-seated, chronic nodules are developed, mostly on the legs below the knee. At first there is no pain and the lesions cannot be seen, though the skin over them often shows a violet discoloration. Ultimately they break down to form typical ulcers irregular in shape, with rounded edges/

edges and a punched out appearance, the floor, which is somewhat irregular, being moist with serous discharge. This disease occurs most commonly in adolescent girls.

In case of doubt in any of these conditions, the diagnosis can be established by any of the tuber-:culin tests, of which Von Pirquet's is probably to be recommended. The sub-cutaneous reaction would be more valuable by virtue of the focal reaction, but the general symptoms produced are a contraindication. It has to be remembered also, that in scrofulous conditi-:ons, any or all of the tests may give a negative result.

6. In addition to the purely tuberculous dermatological conditions mentioned, there exists a motley group of so-called tuberculides, having certain features in common, viz: indolent granulomatous lesions tending to break down, - whose connection with the bacillus tuberculosis is not quite established. When such cases are complicated by enlarged glands and ulcers, they should be treated as products of the organisms of tubercle.

7. Lupus Vulgaris is proved to be a tuberculosis of the skin, the essential lesion of which is a new growth in the corium. The nodule is soft, translucent and brownish red in colour, hence the name "Apple jelly nodule" sometimes applied to it. The skin is destroyed/

destroyed, either by ulceration, - (lupus exedens) or by atrophy, (lupus non-exedens). The patch spreads slow-:ly and superficially, sometimes partly healing in one place and spreading in another, while the surface is often covered with branny scales, which, however ,do not conceal the characteristic redness. The centre may heal and show a scar like that of a burn. Ulceration may supervene, a granular sore with greenish-black crusts being formed and spreading both superficially and deeply, so that necrosis of cartilage e.g. of the nose, may result.

In cases of doubtful diagnosis old tuberculin may be used, when an intense focal reaction occurs round the patch. Opinions are diverse as to the proportion of patients having lupus who develop general or pulmon-:ary tuberculosis. There can be no doubt that a certain proportion do, and, lupus being essentially a disease of early life, its early recognition and removal must be regarded as important in the prevention of severer disease.

4. Miliary Tuberculosis.

By this is meant a generalised tuberculosis wherein many lesions start in various parts of the body at approximately the same time. Even in ordinary pulmonary cases it is a common mode of termination, but it/

it is of especial importance in children because they are particularly prone to such a generalisation of the disease. It is never primary, but is always second-:ary to some lesion, as in glands or lungs, though it may occur after disease of the pleura, peritoneum etc. It is brought about by reinfection through the blood stream, the tuberculous material finding its way there, either by erosion of a focus through a vein wall, or by way of the thoracic duct. It is thus comparable to pyaemia.

Although practically all the organs of the body are affected, some are involved in a greater degree than others. The organs in which the miliary tubercles are most numerous are, as a rule, the lungs, liver, spleen, kidneys and serous membranes. The meninges are generally extensively affected, and thus tuberculous meningitis is most commonly a manifestation of a general miliary tuberculosis. Tubercles, though of approximately the same age, vary very considerably in size.

Three main types of acute miliary tuberculosis are recognised, according to the predominating symptoms. They are: Acute generalised tuberculosis, acute pul-:monary tuberculosis, acute meningeal tuberculosis.

(1) The symptoms of acute generalised miliary tuberculosis/

tuberculosis are those of a severe infection, so that the toxic element obscures all others. At first the symptoms are very obscure, being mainly weakness, anyrexia headache, nausea and loss of flesh. Fever soon appears and is of irregular type, but may be continuous, remittent or intermittent. As a rule the evening temperature is at least 2 ^{o} higher than the monring. The bowels may be constipated or loose, and the urine may contain a trace of albumen. The tongue is dry, the pulse rapid and feeble; and delirium comes on, deepening into coma. Physical signs may be few or almost absent throughout, or diffused râles may be heard over the chest as in bronchitis. Also cerebral symptoms, as strabismus, ptosis, paresis of limbs etc. may be found. The respirations are commonly rapid and Cheyne-Stokes breathing may end the scene. In children we may distinguish two main types of generalised miliary tuberculosis, (a) the marantic form, and (b) the typhoid form.

a. In young infants tuberculosis is but very rarely a cause of marasmus, but "rarely" does not mean "never," and it is imperative in a case of rapid and progressive wasting, that a careful search should be made for miliary tuberculosis. The tubercles, in the main, will be situated in the peritoneum, bowel, lungs and pleurae in the more chronic cases, and it is common in cush young infants/

infants to find the lungs more affected than the abdomen.
b. The typhoid type, is that described. Prostration is severe, diarrhoea is present, and the clinical picture is very similar to that of enteric fever. The differential diagnosis may be from the following points:

(1) Irregularity of the pyrexia.

(2) The absence of rose-spots.

(3) Inability to isolate the B. typhosis in a blood-culture.

(4) Widal's reaction is negative.

(5) Examination of the fundus oculi may demonstrate the presence of small tubercles in the choroid.

(111) The pulmonary form differs from the above, in that, although tubercles may be disseminated throughout the body, they predominate in the lungs, and therefore pulmonary symptoms have a special prominence. The tubercles in the lungs may be diffused or grouped, and generally are most numerous just beneath the pleura. Areas of collapse and consolidation may be found.

As a rule the onset is sudden, although there may be a history of cough for some time previously, while in children, an attack of measles or whooping-cough may have preceded it. Although there may be but little cough, respirations are rapid and there may be considerable dyspnoea. Sputum is generally not copious, and is mucous or muco-purulent in character, and tubercle bacilli/

bacilli are seldom found. There is considerable fever and cyanosis is well marked. The physical signs are those of bronchitis and emphysema, i.e. hyper-resonance, with sibil-:ant rhonchi and medium crepitations.

A subdivision of this form is the broncho-pneumon-:ic type where areas of dulness are discoverable at the bases. The duration in this class is generally shorter than in the bronchitic.

(111) The meningeal form is represented by the tuberculous meningitis already described.

Diagnosis in miliary tuberculosis is extremely difficult and must be made mostly on the history and general appearances of the case. Tuberculin is of no value, for the tests have generally a negative result. Furthermore, by the time there is acute miliary tuberculosis, there is practically no hope of cure, so that there is only the more strongly impressed upon us the necessity of making a diagnosis, when there is one isolated, latent-active or latent-inactive focus in the body.

5. Tuberculosis of other Organs.

Tuberculosis of other organs of the body is so rare in children apart from miliary tuberculosis, that we need not enter into a description here of the manifesta-:tions in such situations, with the exception of tubercul-:osis of the intestine, peritoneum and abdominal glands, in/

in both of whom an early diagnosis is important.

Tuberculous peritonitis is common in children, being as a rule secondary to glandular or intestinal tuberculosis, and sometimes to disease of pleura or lung. The characteristic feature is effusion.

The mesenteric glands are often affected, especially along with the intestine. The diffuse type, tabès mesenterica, is generally fatal, but frequently an accurate diagnosis made earlier would save such a con-:tingency. The lower end of the illium, and the caecum are prone to tuberculous ulceration, and the ilio-caecal glands frequently become enlarged, and adhesion or kinking of the bowel may be produced.

The symptoms in the early stages are obscure, consisting of vague pains of a colicky nature, occasion-:al sickness, sometimes diarrhoea, with loss of weight. A useful rule is:- Where a child is pale; has occas-:ional diarrhoea; is always "tired"; takes food well at times, and sometimes not; loses weight; and has fugutive abdominal pains, have his abdomen X-rays <u>without</u> a bismuth meal, then with, and carry out tuberculin tests. Too little attention I think, is paid to such examinations, for it not uncommonly happens that children with abdominal glandular lesions develop pulmonary disease later. I have collected

eleven/

eleven cases where abdominal symptoms in children preceded pulmonary, while, in those who have continued pain and diarrhoea, I have found a positive tuberculin reaction in more than 80%.

TREATMENT.

The treatment of tuberculosis may be divided into two classes:- A. Prophylactic. B. Curative.

A, Prophylaxis.

This subject has been briefly touched upon in the introduction, but much remains to be said. There are two means at our disposal, - firstly, administrative prophylaxis, and, secondly, personal prophylaxis. Under the first heading come all the legislative measures that may be introduced by local authorities.

1. Housing. So long as the houses of the masses are inadequate in size and cubic capacity, tuberculosis will be rampant. It is necessary that a thorough and periodic inspection be made, and that houses sufficient to the needs of the people, equipped in every way, allowing ample space between and adequate recreation ground, should be provided. Overcrowding at all costs, is to be avoided.

2./

2. Sanitation. One can conceive of no greater evil lurking in our midst than the common lavatory. This is only too prevalent in the working-class districts of our towns, and ought to be replaced by the inside water-closet, used by one family alone. Rubbish-heaps and manure-heaps should not be permitted near habitable property.

3. Flies. An intensive campaign against the house-fly would be a valuable aid in removing the danger of infection. Much can be done by the careful disposal of refuse, coupled with a systematic slaughter of the pest.

4. Inspection of Slaughter Houses. This is now carried out in most communities, and every carcase, before being removed, requires to be examined by a qualified person sanctioned by the local authority.

5. Inspection of Milk. This is even more important that the inspection of the slaughter-house, but receives less attention. True, dairymen are liable to have their milk examined, but more attention is paid to the proportion of fat and solids. It is of more importance to ensure that milk is free from tuberculosis. The following measures are to be recommended:-

a. Periodic inspection of dairies.

b./

b. Inspection of cows.

c. Inspection of carts.

d. Periodic taking of samples of milk for bacteriolo:gic-:al examination.

e. Inspection of methods of milking, separating, storing and conveying milk.

For this purpose a sufficient number of inspectors would be required and special legislation would be called for, with the incurring of considerable expense, but the end would certainly justify the means.

6, Compulsory Notification of tuberculosis. This has been a great step forward in the prevention of this disease. With it is closely allied the development of tuberculosis clinics, sanatoria, and the medical inspection of schools. Voluntary notification was started in 1899 in England at Brighton and Manchester, though the previous year, compulsory notification had been started in New York. Sheffield was the first town in this country to adopt cumpulsory notification in 1904. Since then the system has become general. By this means every diagnosed case is brought to the notice of the local authority. In regard to tuber-:culosis, the duties of the medical officer of health are purely administrative, and the notification is passed on to the tuberculosis officer. It then

becomes/

becomes his duty to determine upon the course to be followed.

We are still far from having an ideal method in dealing with tuberculosis, chiefly perhaps, because too much latitude is allowed the people, for, while in the case of diptheria, a case may be ordered to Hos-:pital and must go, no such power is possessed in relation to phthisis. More and better legislation is needed. We can, however, within certain limits accomplish a good deal, more especially if there is a co-operation between the General Practitioner, the Medical Officer of Health, and the School Medical Officer.

The first thing to be done is to attempt to ascertain the source of infection. This may be (1) domestic, (2) occupational, (3) public-house. Much painstaking inquiry is here needed, and some-:times no doubt, it will remain impossible to find a likely source of infection. The next step is to train the patient, and the patient's friends and attendants. The all-important matter is the sputum disposal, which has been fully considered in the introduction. Thereafter, the question of sanatorium treatment requires to be faced.

In connection with prophylaxis, education

plays/

plays a most important part. It should be begun in the Schools with instruction in general laws of hygi-:ene, but it should not end there. The popular lec-:ture, the pamphlet, the notice in public buildings, should carry on the work. What require to be taught are:- the value of fresh-air and nourishing food; the avoidance of over-crowding; the disposal of sputum and excretions; and the use of exercise in the open.

Collaboration of education authorities and medical officers of health is a most valuable matter in early recognition of cases, and prevention of spread of the disease. The system of medical inspection of schools provides for the examination of each child at least three times during its school career. It should not end here. In the first place, teachers should be trained to recognise and to be on the look-out for early suggestive signs, and in such cases, provisions should be made for the special examination of doubtful children. These might be notified to the local authority and then kept under observation by the tuberculosis officer.

Free examination of sputum is provided by most local authorities, and the dispensary gives free treatment and advice. Advice from this institution is/

is of more importance than treatment, for it deals, not only with the person affected but with all those with whom he may come in contact. The tuberculosis officer can assist the school medical officer mater-:ially by ascertaining the home conditions of sus-:pected cases. All children found to have active tuberculosis should be excluded from school, while those with a bad family history should receive special attention directed towards avoidance of fatigue, feeding and general hygiene. In the schools themselves, classes should be small, rooms well ventilated, and sufficient time should be allowed for out-door exercise.

In this district, the following is the scheme employed:

School medical officers and nurses are provided. The nurses make frequent visits to the schools, and report on cases of suspected disease to the medical officer, who systematically examines every child at least three times during his school career. If any condition is found requiring attention, a double post-card is given to the child. One half is addressed to the child's family physician, the other to the school medical officer. The doctor is thus notified of the condition and is asked to sign and return/

return the other post-card which reads: "I have been consulted by _____, and the defect noted is being attended to." The duty then devolves upon the family doctor to take the necessary precautions. Free dental and optical treatment are also provided. In the case of enlarged glands, or other evidence of tuberculosis, a direct notification to the Medical Officer of Health would probably be more useful.

Once a case is notified, the M.O.H., whose duties are purely administrative, passes on the notification to the tuberculosis officer. This official obtains from the physician attending the case as much information as he can, and desides upon the course to be followed. In some instances of course, interference from him is not desired, but so far as possible, every house is inspected with a view to finding the source of infection, and preventing further spread.

The whole family and personal history is studied and the patient examined. Then the housing and sanitary conditions are considered. Cleansing and disinfection are arranged, instructions in hygiene are given, sputum bottles and disinfectants are supplied, with other necessary comforts. It is further arranged for the patient to be regularly attended/

attended, or to visit the dispensary at intervals. Contacts are examined and kept under observation where necessary. In necessitous cases, arrangements are made with the Poor Law Authority to give material assistance, and sanatorium treatment is arranged for suitable cases. Free sputum examination is provided for all.

The sanitary authority provides for inspect-:ion of dairies, slaughter-houses, workshops, bake-houses, and the general arrangements of domestic sanitation.

The system has many imperfections but in the absence of more stringent legislation, is as good probably as can be obtained. Much of course, depends upon the personal energy of the officials concerned and upon active and amicable co-operation of general practitioners with the school medical officer, the medical officer of health, and the tuberculosis officer. A great many of the first named have still got to learn to subject their per-:sonal feelings and advantages to those of the community at large, while the mass of the population have also to realise that the freedom of the individ-:ual must frequently be sacrifised on the altar of the common weal.

B./

B. Curative Treatment.

This is a vast and highly controversial subject which does not come within the scope of the present thesis.

SUMMARY AND CONCLUSIONS.

It is apparent that the problem of tuberculosis is of overwhelming magnitude, but one which can be faced. This disease is preventible and curable. Two main points play a part in prevention:- 1. improvement in housing conditions and hygienic education. 2. early diagnosis of cases. In children the disease is so very prevalent that it should always be in the forefront of the physician's mind, and no stone should be left unturned that may serve to elucidate an obscure condition. Firstly we have to recognise as early as possible, active cases, Secondly, we must search for presumptive evidence of latent cases. The motto is: Examine, re-examine, and examine again, and in examining, start at the beginning, and, above all, be systematic.

The history of the present condition, and the previous health of the child under review, are essential to a thorough understanding of the results of physical examination and should be considered in great detail. Next, the family history very frequently will tend to clear what might otherwise be doubtful, and in many cases will put the clinician onto the proper scent, so that great care is required in note-taking.

The value of inspection cannot be over-estimated. Time and a well trained eye are needed to be able to observe the important but often non-apparent suggestive alterations. Time so spent is often saved, by helping one to get at the root of the trouble right away. After the eye, the hand! Palpation, light and deep in most instances will bring to light valuable details, and will materially assist in the interpretation of results of percussion and auscultation.. Only when such an exhaustive physical examination has been done, should more elaborate methods of diagnosis be resorted to. Of these, tuberculin tests and laboratory methods will frequently serve to prove that tuberculosis is present, but will not show whether the disease is active or inactive. The most useful test is Von Pirquet's, though the subcutaneous as a confirmatory method, and in certain circumstances/

circumstances by virtue of the focal reaction pro-:duced, is particularly valuable. Laboratory methods, chiefly the opsonic index-test and the complement-deviation method cannot be regarded at present as of much use, though a big field probably exists for the latter once it is developed more fully, especially in detecting latent inactive lesions.

In the regional diagnosis, and in local-:ising lesions, X-ray examination is of great importance, while sputum examination helps consider-:ably in lung cases. Special stress is to be laid on lassitude, anorexia, loss of weight and pyrexia in diagnosis, for they frequently exist before localising signs and symptoms. Glands being the first line of defence, and constituting in children the primary lesion, receive special attention. An affected gland should lead one to trace the possible routes of spread, and special search has always to be made for enlargement of the cervical, mandibular mediastinal and peribronchial groups, and in connection with the last, for lesions at the hilus.

The state of the teeth, tonsils, middle-ear naso-pharynx and larynx often gives a useful clue, and, at any rate, restoration of these parts to/

to health is a big step in prevention.

In regard to prophylaxis, housing, schools, inculcation of laws of health and super-:vision of food stuffs are the important general measures, while, from a system of co-operation of authorities, early diagnosis and supervision of cases, together with an active search for "contacts", and the training of patients and their friends, are the most direct methods. All this, however, requires to be very thorough. No half-hearted measures are of any avail, but, by a painstaking application of the methods here set forth, it seems to me possible that a greater proportion of that 90% of infected children will come under medical care for this disease, and the death rate, both in children, and naturally in adults, will be gradually, but surely reduced. At any rate, I have, by such means, found it possible to make a definite diagnosis sooner, and have thus adopted anti-tuberculosis methods where otherwise empirical powders would have been given, and I am convinced that thereby, serious disease has often been arrested.

Bibliography/

BIBLIOGRAPHY.

1. Bandelier and Roepke, - Tuberculin in diagnosis and treatment.
2. Crocket, - Physical examination of the chest.
3. Fowler, J.R. - Pulmonary Tuberculosis.
4. Hogarth, - Medical Inspection of schools.
5. Hutchinson - Conquering consumption.
6. Jordan - B.M.J. Aug. 31, 1920.
7. Kelynack.- Tuberculosis in Infancy and Childhood.
8. Klebs. - Tuberculosis.
9. Koplek. - Diseases of Children.
10. Malcolm Morris. - Diseases of the Skin.
11. Morland and Reviere. - Tuberculin in Diagnosis and Treatment.
12. Muir and Ritchie. - Manual of Bacteriology.
13. Newsholme.- Prevention of Tuberculosis.
14. Newsholme.- Vital Statistics.
15. Osler. - Principles and Practice of Medicine.
16. Philip. - Tuberculosis in its relation to Public Health. Dictionary of Practical Medicine.
17. Philip. - B.M.J. Dec. 1st 1906.
18. Powell and Hartley. - Diseases of the Lungs.
19. Report of Royal Commission on Tuberculosis, 1907.

20./

20. Russel Howard. - The Practice of Surgery.

21. St. Clair Thomson. - Diseases of the Throat and Nose.

22. Stelwagon. - Diseases of the Skin.

23. Still. - Common Disorders and Diseases of Childhood.

24. Taylor. - The Practice of Medicine.

25. Thomson and Miles. - Manual of Surgery.