THE PREVENTION

- of -

TUBERCULOSIS.

- by -

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M.D. 1913

In England and Wales in the year 1904 the number of deaths certified as due to Tuberculosis was sixty to an aggregate of sixty-seven due to the chief acute infectious diseases.

The importance of this fact is enormously increased by the fact that the deaths from Tuberculosis were largely of persons in early and middle life which causes greater distress and loss to the community.

The mortality from Tuberculosis for the year 1904 gave a death rate in England and Wales from Phthisis:

Males	1.46 per 1000
Females	1.03 " "

The importance of pulmonary phthisis in maintaining the death rate may be more clearly demonstrated by reproducing the following table which gives the mortality at different ages from Phthisis and other diseases and the increase of expectation of life produced by the elimination of Phthisis.

Survivors & Future Expectation of Life at Different Ages in Males.

Age	No.of Survivors at each age out of 100,000 born.		Future Expectation of Life (Mean After Lifetime).		Percentage Increase in the Expectation of Life produced by the Elimination of Phthisis.
	Based on the Mortality from all Causes.	Based on the Mortality from all Causes excluding Phthisis.	Based on the Mortality from all Causes	Based on the Mortality from all Causes except Phthisis.	
0	100,000	100,000	44.1	46.3	5.0
5	75,093	75.256	53.4	56.2	5.3
15	72.592	72.897	45.1	47.9	6.3
25	69.446	70.654	36.9	39.2	6.3
35	64.716	67.676	29.2	30.8	5.3
45	57.655	62.138	22.2	23.0	3.9
55	47.424	52.742	15.8	16.2	2.3
65	33.163	37.830	10.3	10.4	1.0
75	15.813	18.303	6.1	6.2	
85	3.121	3.629			

Mortality returns showing the age incidence must be summarised from all available statistics as a basis for estimating the importance of the problem. These show that the disease is disseminated widely without limitation by race, climate or other influence which contribute in many cases to the limitation of disease.

Its incidence is more affected by circumstances of

social organisation and where these are similar the incidence varies but slightly.

The virulence appears remain about the same as in the past.

We may thus consider the condition in England and Wales as typical of a much wider community. On the basis of incidence, age incidence and mortality, we may attempt to estimate the economic loss to the community.

We must include in generalisation:

1. Deaths at all ages.
2. Economic importance of deaths at various periods.
3. Deterioration of national health and efficiency among cases cured or whose death is due to intercurrent disease.

The ages at which death occurs from Pulmonary Tuberculosis are those at which the individual is commencing as a wage earner to return to the community the capital which has been invested in his education and training or the earlier years of the period in which his efforts are of most value to the state.

The following table gives the proportional mortality at the different ages.

Proportional Mortality from Phthisis

Age.	Males. 1. In proportion to 100 Deaths from Phthisis at all Ages.	Males. 2. In proportion to 100 Deaths from all Causes in the same Age period.	Females. 1. In proportion to 100 Deaths from Phthisis at all Ages.	Females. 2. In proportion to 100 Deaths from all Causes in the same Age period.
0	3.1	0.7	3.4	0.7
5	1.1	4.2	2.0	5.7
10	1.4	9.5	4.3	20.6
15	5.6	26.1	9.7	35.4
20	10.8	38.5	11.9	36.7
25	23.1	37.0	25.3	32.3
35	22.8	28.1	20.3	21.2
45	18.9	18.2	13.0	11.2
55	10.1	7.7	6.9	4.4
65 & upwards	3.1	1.4	3.2	0.8
All Ages	100.0	8.5	100.0	6.0

Here it is seen that after the age of twenty when the earnings commence to more than balance the personal expenditure the mortality from phthisis is highest and remains high until the period of failing energies above the age of fifty-five to sixty years. Thus the economic effect of this high

mortality is given an appearance of enormous influence.

Of further proof of the effect of the disease on the health and efficiency of the nation, we may add the number of persons rendered incapable of independence at present supported by Boards of Guardians and other charitable organisations.

The total gives an idea of the destruction caused by Pulmonary Phthisis. To this must be added the deaths due to other forms of Tuberculosis. The death rate for 1904 from the Tuberculous diseases other than Phthisis was 54 per 100,000. The proportion for Tuberculous diseases other than Phthisis being 30.5%

The total gives Tuberculosis a precedence in importance over other diseases in its destructive effect on the state.

How this may be reduced and minimised, forms the subject of the Thesis.

THE SOURCES OF INFECTION

The recognition of the contagiousness of Tuberculosis brought about by the work of Villemin on experimental evidence, prepared the way for Koch's announcement of the discovery of the bacillus in 1882 and inaugurated a new period in the history of the disease.

Koch failed to find a distinctive organism stain by ordinary methods but succeeded in staining the bacilli by an alkaline methylene blue. Erlich improved on this and discovered the method of decolorising by acid which takes the stain from the preparation, leaving the bacilli deeply stained.

The bacillus contains a fatty or waxy matter which retains the stain when other organisms are decolorised. The technique of staining has been elaborated and several precise methods are employed. These are all on the same principle as the recognised Ziel-Neilson method which requires the use of a solution of fuchsia in alcohol for staining and an acid solution in alcohol for decolorising.

Two types of bacilli are found in man, the human and the bovine. The human bacillus is a slender rod, 0.3 micromillimetres in thickness, 1.5 M. in length. In old cultures aberrant forms are found, filamentous, branched or clubbed. The bacilli often stain unevenly, presenting a beaded appearance. These are more commonly found in sputum and it has been suggested that this is associated

with the saphrophytic growth of the organisation in sputum.

The bovine bacillus is shorter, thicker, very short forms occur. The beaded forms are not common. The two types are said to approach one another in characteristics on long cultivation.

HISTORY OF THEORY OF INFECTIVITY.

Discussion as to the possibility of infection in Phthisis has been pursued since Hippocrates and Galen supported the theory. Avuenna, 1037, spoke of it, referring to diseases "taken from man to man like Phthisis."

In 1746 in Italy, legislative enactments were put into motion with regard to disinfection of infected articles used in "hectic phthisical and other contagious diseases."

These views were held in England about the same time and doubtless in other parts of Europe. Medical opinion generally tended from this time to the theory of infectivity by contact.

Villemin's experiments, 1865, gave the first experimental evidence by inoculation.

Infection by inhalation followed and was demonstrated by spraying animals with emulsions of cultures and infected dust. Later experimental feeding with tuberculous material has proved infection by ingestion.

How far the last method is responsible for infection is not yet decided.

The problem of the prevention of Tuberculosis is closely connected with investigation of the importance which these portals of infection possess. They must be considered, therefore, separately and in detail.

DETAILS OF EXPERIMENTS.

Inoculation was the first method of infection which was proved by conclusive evidence.

Villemin followed up the work of Klencke, who had successfully produced tuberculosis in rabbits by injection of tissue from tuberculous lesions by venous infusion.

Villemin, in 1865, inoculated rabbits with tuberculous tissues. For controls, he injected other animals with pus non-tuberculous and kept other animals in the same environment.

The results showed:

1. The tuberculous injections showed pulmonary tuberculosis.
2. Those infected by ordinary pus did not.
3. The other animals remained free.

He summarised his results as follows: Tuberculosis is a specific affection caused by an inoculable agent."

Villemin first drew the distinction between the virus causing the disease and the lesions produced by it.

Opinion remained, however, either opposed to the idea that the disease was commonly inoculated or is, in any way, to be regarded as distinctly infectious.

Partly this can be explained by the varying results of experiments in other workers' results.

Chaveau and Klebs, in 1873, and Baumgarten and Cohnheim in 1880, showed that the results in these last

series were explicable on grounds of faulty technique.

Inoculation as a means of spread stood clearly proved before the discovery of the organism.

Chaveau had also demonstrated infection by ingestion of the morbid secretions of tuberculous patients.

Then followed the period when the attention of Pasteur and Koch which resulted in the discovery of the specific organism.

Following Koch's announcement of his discovery of the organism, its cultivation and inoculation, Villemin's views came to be accepted.

Since this time the pure cultures of the bacillus being available, an enormous amount of work has been done to define the limitations of infectivity, and to define the exact channels of infection.

The inhalation and ingestion of tuberculous material had been already demonstrated. This also had been proved as capable of infecting by inhalation and ingestion of cultures of bacilli.

The evidence of infectivity may be referred to classes according to the portal of infection. The evidence is experimental and clinical.

Experimental may be summarised:

1. Inoculation. Cultures and sub-cultures from tuberculous material inoculated into animals produces typical tuberculous lesions.
2. An atmosphere impregnated artificially with dust or moisture will produce lesions in the lungs and elsewhere.

3. Experimental tuberculosis may be produced in animals by feeding them with tuberculous material.

The experimental evidence supports the following conclusions:

1. That tuberculosis is due to a specific bacillus.

2. The disease has been produced in animals by introduction by:

    1. Inoculation.
    2. Inhalation with inspired air.
    3. Ingestion with food.

That similar infection occurs in ordinary circumstances in man is supported by extensive evidence, circumstances which to some extent produce the experimental conditions appear responsible for the infection.

In the table of cases at present under my care, included in discussing prevention of infection of 100 cases, 51 cases are explicable by infection in circumstances resembling the experimental conditions.

THE METHODS OF INFECTION

The old classification of the methods of infection is the following:

1. Heredity. Transmission of the bacillus direct in utero.

The evidence for this is sufficient but reduces the frequency to the lowest of the methods of infection. Unless there is more evidence for the probability of long latency, this must be a negligible factor.

2. Inoculation, cutaneous or mucous.

Membrane inoculation is recognised but is only of occasional occurrence.

3. Inhalation.

This is now considered on the evidence of exposure and infection to be the most important method.

4. Ingestion.

This to rival the previous method in importance, would demand belief in long latency as adults seem less susceptible than children, in whom the infection mostly occurs and would lead to the expectation of more adult infection by the bovine type of bacillus.

These methods will be discussed in the order of their importance.

Inhalation.

Koch experimentally proved the easy possibility of infection in this way by spraying cultures and other experimentors by the dissemination of dry dust. Flugge, as a result of his investigations, afterwards modified by Heyman, and Cornet attempted to give limitations to this method of spread.

Flugge credited the method of spread by the inhalation of small droplets discharged by coughing. This latter method, however, whilst probably a regular mode of infection is much less important than conveyance by dry dust.

Koch, as a result of his experimental investigation, said:

"Dried sputum is much more likely to cause infection "as, owing to the negligence with which the expectoration "of phthisical patients is treated, it must evidently enter "the atmosphere in considerable quantity. The sputum is "not only ejected directly on to the floor, there to dry up, be pulverised and rise again in the form of dust, but "a good deal of it dries on bed linen, articles of cloth- "ing and especially on handkerchiefs, and this too is sub- "sequently scattered as dust."

The following paragraph is amongst the decisions of Cornet.

"The dust of rooms was regularly virulent in the

"instances in which the patient had been in the habit of "spitting into his handkerchief or on to the floor."

Cornet found virulent bacilli in the dust of a room in which a patient had died of phthisis six weeks previously.

Flugge, however, minimised the importance of infection in this way and said that he was only able to get infection in circumstances simulating those around a careless consumptive. In ordinary conditions, he believed infection was more common by droplets discharged into the air in the act of coughing.

Heymann, however, experimentally proved that the duration of suspension of these droplets is not very long and consequently the amount of infection received in this manner must be small. That it is a mode of infection in conditions of intimacy, appears undeniable.

In tuberculous laryngitis bacilli can be freely swabbed from the larynx in huge numbers. In the frequent coughing doubtless large numbers are discharged in droplets, but probably these find their means of spread most commonly as dried particles of dust.

Lest the danger of infection from dust be exaggerated, the following investigations of Professor Delefine are interesting:

Class I. Dirty Houses containing consumptives who used no Precautions.	Class II. Clean houses containing Consumptives not sufficiently careful.	Class III. Clean Houses in which Consumptives had not lived.
The number of houses from which dust was examined was 23	10	10
The number to be excluded because the inoculated animals died rapidly after inoculation was 2	0	0
The number found infective by inoculation (one by microscopic examination only) was 14	5	0
Thus the percentage of infected houses 66.6	50.0	-
The average size of the infected rooms was . . . . . .475 c. ft.	336 c. ft.	-
The average size of the non-infected rooms was . 368 c. ft.	506 c. ft.	-
The lighting and ventilation was -		
Good in 5 positive & 7 negative cases	In 1 positive & 5 negative cases	-
Fair in 1 positive & 1 negative case	In 2 positive & 0 negative case.	-
Bad in 8 positive & 1 negative case	In 2 positive & 0 negative case.	-
Samples were taken at different levels in . . . . . 16 houses	-	-
Of these samples the number found infective was 13	-	-
Of the infective samples the number near the floor was . . 9		
4 to 6 feet above the floor was 13	-	-

The table indicates that the infectivity is limited by the cubic space of the rooms, the lighting, ventilation and other factors, and that infection is not to be expected beyond the immediate environment of consumptives. It will be again referred to in discussing methods of prevention.

INFECTION BY INGESTION

Experimental evidence, as mentioned previously, is conclusive that this is a possible mode of infection.

In this respect the following statements which have received acceptance are important:

1. The bovine and the human type of tuberculosis are each inoculable into man and animals.
2. Authorities place the amount of tuberculous cattle at from twenty to thirty per cent. Animals which appear healthy are often infectious.
3. Mixed milk has given an average of twenty per cent of samples containing tubercle bacilli.
4. About one third of the deaths of children under two years is due to tuberculosis. (Landowzy).
5. Tuberculosis in children is frequently of bovine bacillus infection.

Von Pinquet has shown that a great number of children apparently healthy, give a positive reaction to tests for tuberculosis. Many investigators consider that adult phthisis dates from infection in childhood. This will be referred to in discussing latency.

The infection by ingestion which does occur, appears to be due to infected milk rather than to milk derivatives or to meat as the infection is freely found in milk which is mixed for transit and sale and occurs in children at the age when it is their principal food.

Bacilli can be found in butter and cheese.

Tuberculous meat does escape condemnation at the abattoir to some extent but the probabilities are against their being responsible for more than a very small amount of infection.

Infection through the skin does occur but usually sets up only local and slight lesions, but is capable of rapid lymphatic spread and subsequent dissemination. However, it seems rare and so easily avoided that it can be dismissed as a source of infection.

Direct transmission.

In Tuberculosis during pregnancy, the placenta is frequently implicated and may thus permit foetal infection. Bacilli have been found in the organs of the foetus apparently transmitted in this way, but as a cause of tuberculosis in the adult is probably a negligible factor.

INFECTION BY INHALATION

The nature and source of the infective material being surmised, it remains to decide how this effects an entry into the tissues and finds means of spreading.

Inhalation directly on to the acini of the lung must be rare. It is checked by the fact that:

1. The tidal air only mixes with the residual air of the lungs slowly, making direct inhalation into acini only possible after a number of respirations.

2. The tidal air if infected in its passage through the respiratory passages meets many impediments which tend to check the inhalation of bacteria.

The shape and complexity of the respiratory passages.

Their mucous lining and their continual cleansing by the action of their ciliated epithelial lining.

The usual course appears to be that bacilli escaping these protecting agencies, effect entry at the point where they are arrested and spread by the lymph channels.

Decayed teeth, which are well recognised portals of entry for other bacteria, have been proved to be infective for tubercle bacilli. They have been found infected in the pulp and scrapings from surrounding tissue have shown tubercle bacilli.

Adenoid growths are suspected with some show of evidence. Morgan, Thomson and Dieulafoy have demonstrated tuberculous infection in 5-20% of removed adenoid growths in children.

Tonsils. The examination of tonsils removed for hypertrophy or morbid changes has enabled proof to be obtained of the frequency of tuberculous changes in apparently healthy simply enlarged glands.

Walsam states in the review of his post-mortem examinations investigating the origin of infection of cervical glands: "That the microbe may and frequently does "penetrate into the tonsil, the cervical glands becoming "secondarily affected, there can be no doubt, and I think "the so-called scrofulous gland receives the virus in this "way. It is still an open question whether or not the "lung can be infected by gradual extension of the bacilli "downward with the lymph stream.

"I think in those cases where we find the tuberculous "change in the cervical glands further advanced than in the "bronchial, we may assume that the lung has been infected "in this manner."

The Nose and Larynx.

Primary tuberculosis of the nose is well recognised but is usually limited in its spread. However, as a focus for infection, its importance must not be overlooked. The larynx may be affected before signs are evident in any other organs, but the frequency of secondary infection in very early pulmonary tuberculosis obscures its importance as a portal of infection.

Bronchial glands.

Walsam gives a series of reports of autopsies in

support of the theory that more particularly in children infection of lung or of tissues through the blood and lymph streams takes place through bronchial glands. He traces the infection from tonsil to cervical glands, thence to bronchial and from these to thoracic duct, right side of heart, pulmonary artery and lungs. This method is recognised as the probable cause of diffusely spread miliary tuberculosis.

Walsam says definitely that in childhood infection is generally through the bronchial glands.

PORTALS OF INFECTION

Ingestion.

The exact mode of entry of the bacillus in the stomach and intestine is not clear from the results of the post-mortem examinations which suggest these tracts as the origin of tuberculosis.

Lesions of the intestine are only occasionally found in cases of infection of the mesenteric glands. Enlargement and tuberculous changes can be found in mesenteric glands of cases certainly infected by other channels.

Therefore, impressions must be corrected by experimental and case observations.

The statement of Delefine may be quoted as positive evidence of this method of infection.

In a series of over 300 experiments, I have found that tuberculosis of the mesenteric glands occurs extremely late in animals infected through other channels than the intestinal canal and peritoneal cavity and am absolutely convinced of the value of pymphatic glands as indicators of the path followed by tubercle bacillu in cases which have died before the disease has become too advanced.

According to Dr. Woodhead the post mortem examinations of the bodies of tuberculous children who died before the age of five and a half years show that in the large majority of them the intestine and mesenteric

glands were affected; and that in 14% of those cases the mesenteric glands alone were tuberculous.

Walsam, in his post mortem reports, traces infection from cases of tuberculous peritonitis to the bronchial glands and thence to lung parenchyma.

The experiments of Calmette and Guerin indicate that tuberculosis of bronchial glands and lung may be produced by ingestion with little or no apparent change.

The review of modern research is increasing the importance of ingestion as a method of infection, at the same time showing its close relation to inhalation. In this respect the work of Vansteenbergh and Grysey is interesting and conclusive, and has been confirmed by the reports of Sir William Whitla and Professor Lymmers of Belfast.

Finely divided emulsions of living bacilli ground up in an agate mortar with decoction of linseed were infected into guinea pigs' stomachs and were absorbed by the intestinal surface producing extensive tuberculous deposits in the mesenteric glands, in the lungs and other viscera.

When the animals lived beyond 30 days, the lungs were invariably found to be studded with caseous tubercle, and the broncho-tracheal glands also suffered.

In the guinea-pigs which survived the ingestions from 50-60 days, the deep cervical glands were nearly always found to be decided by tuberculous.

The involvement of the cervical lymphatics is of the utmost importance, as the usually accepted theory is that when these glands are found to be tuberculous in the human subject, they prove that the bacilli have effected an entrance through the mucous membrane of the mouth, tonsils or pharynx. We know now from the researches of Nicholas and Descos, Ravenel and Von Behring that the tubercle bacillus can pass through the intestinal mucous membrane without causing any lesion or leaving any local evidence of its point of entrance. Thus the possibility and indeed the probability of the lungs and lymphatic system being infected through the intestines is proved without doubt and the converse, i.e. the improbability of lung infection by inhalation is shown by an instructive experiment of Vansteenberghe and Grysez, who submitted rabbits and guinea pigs to an atmosphere laden with fine carbon particles by keeping them in a glass cage in which a lamp fed by turpentine was burning.

The upper air passages were found laden with carbon, some of which had also found its way into the pulmonary alveoli when the experiment was of long duration, but in no case was carbon found in the lung parenchyma. These observers were, therefore, justified in their conclusion that physiological anthracosis is due in such cases to intestinal absorption of particles arrested in the pharyngeal and nasal passages and afterwards swallowed

with the saliva and nasal mucus, to be carried to the pulmonary parenchyma by the blood stream.

The conclusions from the evidence given are that the sources of infection may attack the organism by various paths with or without traceable lesion and spread to the lung by lymphatics or from the lung by lymphatics and glands to other viscera. The spread of the disease may be complicated but the main channels of infection dependent on inhalation and ingestion are clearly proved.

The other less important methods of infection have been discussed in dealing with sources of infection.

We have now traced infection by aerial spread from its source to its nidus for growth and later spread in another organism.

Before passing on to discuss the methods by which this infection may be prevented, we may first discuss susceptibility.

Susceptibility.

Susceptibility to tuberculosis is the result of many causes acting together. In individual cases, one factor may be of outstanding importance.

Of these, heredity plays a part of some importance. This part, however, is not regarded as nearly so important since the other factors have been more carefully estimated.

In the following table compiled by Squire from cases at the North London Hospital, an average of nine per cent is shown for hereditary predisposition from the history of one thousand cases.

Of 1,000 cases, 325 gave a history of Phthisis in one or both parents.

Apparent hereditary predisposition, 32.5%

Table showing the incidence of Phthisis on the children of non-phthisical and phthisical parents respectively.

474 cases	Children		Died in Infancy		Phthisical	
	Total No.	Proportion to each family	Total No.	Per cent of whole	Total No.	Per cent of children, excluding infantile deaths.
A. 275 families Parents non-phthisical	1745	6.34	193	11.06	386	24.87
B. 84 families Father phthisical	511	6.08	67	13.11	138	31.8
C. 82 families Mother phthisical	506	6.17	56	11.06	155	34.4
D. 33 families Both parents phthisical	165	5.0	18	10.9	58	39.45
B,C,D. 199 families One or both parents Phthisical	1182	5.93	141	11.92	351	33.71

In the latter portion of this Thesis is included a table giving the number of cases with apparent hereditary predisposition at present under care in the Sanatorium wards

under the Metropolitan Asylums Board. Of 100 cases investigated, 34 give a history of phthisis in one or both parents.

In these cases the hereditary predisposition is by no means proved, but merely suggested. The influences of environment acting on several generations of a family are capable of giving a predisposition which is not hereditary.

These influences which act continuously from generation to generation are deserving of consideration.

This is sufficient to prove that heredity is not a factor which predominates in the way that was, until recently, supposed. Those circumstances which produce what Baldwin calls conditions of sub-normal resistance have more influence in the majority of cases probably than heredity which implies a liability to this disease over all others.

Amongst the influences which may predispose, we may consider:

Faulty heredity, not special to tuberculous.

Decadent families show a predisposition to disease which does not exclude tuberculosis. The strain of reproduction in women with the periods of pregnancy and lactation gives periods of special weakness of defence,, giving the individual less chance of resistance to tuberculosis. This may be instanced by the relation between physical degeneracy and disease.

Local conditions, inherited or acquired, may predispose.

The portals of infection may by inheritance or by the changes of accident or disease, be made more possible.

Behring laid great stress on specific liability due to previous infection, lymphatic or pulmonary.

The other infections preceding infection by Tuberculosis are probably the most important factors of this group.

Pneumonia is second to Influenza in Baldwin's estimate which gives Influenza as antecedent in 15.5%. Colds were recorded in 22.2%. Bronchitis, Typhoid and some other diseases have a recognised but undefined relation.

The most serious predisposition appears in Diabetes, of which about one-third or more die of tuberculosis.

Insanity offers a high mortality from tuberculosis, but in this case the circumstances of environment have to be considered.

The causes of subnormal resistance may be more successfully found in the conditions of environment and the habits to which they predispose.

Tuberculosis is most prevalent and most fatal in circumstances of poverty. The complex factors which produce conditions will be considered under the means of prevention.

Over-crowding, insanitary habits, insufficient food and clothing produce individuals not fitted to resist tuberculosis in circumstances where infection is difficult to avoid.

In the vicious cycle produced by poverty and disease

are produced the circumstances which collectively sustain the widespread prevalence and high mortality.

In the social circumstances suggested by the occupations and hours of work of the hundred female wage earners included in the discussion of means of prevention, are to be found the conditions predisposing to the condition of subnormal resistance.

P R E V E N T I O N.

Tuberculosis is essentially a disease of crowded populations, of indoor occupations transmitted by infection, largely dependent on insanitary conditions and predisposed, too, by previous disease.

The means of prevention must deal with the individual and with the environment as is expressed by Osler with the seed and with the soil. The measures are direct and indirect.

The indirect measures are of immense importance. They include:-

(1) Inculcation of general laws of hygiene.

Increasing attention is now being paid to the teaching of simple principles of hygiene in the elementary schools. It is through these schools that the individuals pass who are to form the majority of cases of tuberculosis in their years of early adult life and it is the classes they educate that require to struggle with the most faulty hygienic surroundings.

Fresh air as a preventative of disease, the value of cleanliness require to be emphasised and more should be shown capable of attainment and compatible with comfort.

(2) Prevention of malnutrition alcoholism and conditions of over-fatigue.

These are possible even in circumstances which we describe as "Poverty" by better administration to avoid malnutrition.

The ordinary diet of the poor is by no means the best that is obtainable by the means at their disposal. Without requiring a great change of habit in this respect wherein people are most conservative as small improvement in the nutritional value of their food when combined with one other advantage only fresh air would lift a great mass of the population above the line of safety.

Alcoholism appears to be on the decrease and probably will continue to decrease. It will certainly be hastened if the danger to the individual is duly emphasised. It is both symptomatic and causal of poverty and is related to every department in the causation of poverty and disease.

Alcoholism dimishes the resistance power of the individual to every form of infection but apparently more particularly to tuberculosis. It implies frequenting public houses, of which investigation has shown that they are excessively contaminated and a common source of the spread of tuberculosis. The frequency of tuberculosis is higher in attendants in hotels and inns than any other branch of similar occupation.

Exhausting occupations predispose to infective

invasion and the remedies which are available and which are in force require strict supervision more particularly amongst female workers.

An analysis of the hours of work, food supply, intervals for rest and rate of wages amongst young female workers in the workshops of London from which the sanatorium cases under the Insurance Act are drawn, certainly show markedly predisposing conditions. These will be referred to more exhaustively in discussing methods of prevention.

(3). The relation to poverty and housing conditions is one of the most important and most difficult problems in attempting prevention of the environment in which infection will take place and cases, if neglected, do badly and spread further infection. However, the means of prevention are of considerable efficiency under these conditions.

In the table of analysis of the comparative infectivity of three classes of houses previously included, we see that light and ventilation depress infectivity even in poor houses with careless consumptives. In the class of more careful consumptives this is again reduced. Careful measures could minimise this even in the most unsatisfactory conditions of poverty. We also see that dirty houses are not necessarily infective.

Thus the difficulty of the problem is substantially reduced.

The education of the patient and relatives in the measures of prevention by the organisations which are being formed are equal to the requirements even in the present unsatisfactory state of organisation of poor relief and unsatisfactory housing. But the measures must be strictly followed and supervised.

The proof is in the fact that the phthisis death rate has declined when these measures have been followed, far beyond its natural relation to the fall of the death rate. Other factors are of course important, including modern more successful methods of treatment. The changes in the environment which have been produced by better public health administration apart from the department of tuberculosis has claimed a large share in the credit of the lessened death rate. These, however, have had little effect on the sources of infection until regulation with special regard to tuberculosis was included.

Such evidence as mentioned in discussing the sources of infection by inhalation shows that one careless consumptive is an active source of infection even in good hygienic surroundings.

The claim of improved hygienic administration must be more that the soil is rendered less fertile and the claim of the special measures that the dissemination of the seed

has been reduced.

The value of a careful study of the sources and portals of infection emphasises the possibility of attacking the disease by direct measures. Thus special administration for the suppression of tuberculosis is demanded in connection with the measures which are intended to decrease disease. We may refer to the organisations existing for this purpose.

The organisations for the reduction of tuberculosis may be classified in various ways as they are not yet coherently administered and are not clearly disassociated from bodies having other aims. They may be classified as public and private.

The private organisations are mostly sanatoria, seaside homes and convalescent homes. Many have reached a high degree of efficiency but their influence on the solution of the problem must be small, as being expensive they are not open to the majority of cases.

The present situation of the public administration is one of transition.

An effort is being made to control the spread of the disease just as has been done previously in the other infectious diseases.

Special legislation has been framed and organisation of the means of resistance is going on.

The situation has been profoundly altered by the

orders issued by the Local Government Board and by the provisions of the National Insurance Act.

Previously the powers of the local health authorities had not been fully used against tuberculosis and the sanatorium treatment was either in the hands of irresponsible charities or boards of guardians. These were not mutually organised and their efficiency limited to a small number of cases.

With the development of the dispensary treatment organisation of the means of resistance achieved its greatest step towards efficiency. Its relations to the other organisations will be discussed in dealing with these.

The circular of the Local Government Board of December 1912 enacted the following rules for the procedure of local authorities:-

(1) Notification of cases to be compulsory both primary and supplemental.

(2) Cases of non-pulmonary tuberculosis to be included for purposes of notification.

(3) The Medical Officers of Health are to organise methods of sputum examination and report.

(4) Investigation into sources of infection is to be made.

The result of this should be more complete and reliable statistical evidence of the incidence of the

disease and consequent more complete application of methods of prevention.

The recent Insurance Act with its clauses arranging for the treatment of tuberculosis amongst insured persons brings the history to date in dealing with national organisation of prevention.

At present the organisations which deal with the problems of the direct treatment of tuberculosis are the following:-

(1) Private medical attendants.

(2) Panel " "

(3) Poor Law Medical Officers.

(4) General hospital out-patient departments.

(5) Chest hospital out-patients departments.

(6) Tuberculosis dispensaries.

(7) School medical inspectors.

These refer cases to:-

(1) Private sanatoria with or without charitable support.

(2) Poor Law Infirmaries.

(3) Municipal hospitals for early or late cases.

(4) Sanatoria under the National Insurance Act.

Notify to:-

Medical Officer of Health for:-

Disinfection.
Investigation of method of infection.

It is not proposed in this thesis to discuss the

relation of each of these organisations to the problem in the past, but to foreshadow their relations in the future as they will settle to their respective work as units in a greater organisation.

The private treatment of patients may be passed over in saying that it will follow the same lines as the public service.

The present condition of affairs under the National Insurance Act may be investigated from the history of cases sent to the sanatoria.

In the following cases the treatment before admission is by panel doctor only, unless otherwise stated. The history of these cases should be suggestive for administrative organisation.

The following table gives the age particulars of work, treatment, method of infection and element of heredity in 100 cases from the Sanatorium and Hospital Wards of the Metropolitan Asylums Board Northern Hospital.

Age	Occupation	Hours of work.	Previous Institutional Treatment.	Sources of Infection.	
19	Waitress	12	Brompton	? at work	N.H.
22	Housemaid	6 - 10	W.London and T.B. dis.		N.H.
45	Domestic	6 - 10	Frimley	Nursing patient with Phthisis,	N.H.

Age	Occupation	Hours of Work.	Previous Institutional Treatment.	Sources of Infection.	
27	Charwoman	Irreg.	-	Nursing husband milkman,	N.H.
21	Bookfolder	8 - 6	-	Nursing	N.H.
20	Retoucher Photo.	9 - 12	-	Home contact	H.
32	Laundress	12	-	? domestic	H.
20	Domestic	6 - 10	T.B.dispensary.	? domestic	H.
16	Blouse finisher	11½	-	? at work	N.H.
24	Barmaid	12½	-	At work	N.H.
26	Dressmaker	12½	Brompton	-	N.H.
20	Tin box maker.	10	-	At work	N.H.
27	Shop girl	11	-	Home from Mother	N.H.
20	Relief Stamper	10-12	-	-	N.H.
21	Dressmaker	Irreg.	Bognor	Brother	H.
24	Charwoman	"	T.B.dispensary	Husband	N.H.
39	"	"	"	At work	N.H.
22	Printing	12	Chest Hos:	From sisters	H.
25	Domestic	10½	-	-	H.
21	Packer	13½	Sanatorium	From relatives	H.
17	Pattern mounter	8 - 7	-	" "	H.
20	Housemaid	12	-	In childhood ? food	H
21	Tooth Powder Packer.	8 - 6	-	From another worker	N.H.
16	Needlework	8.45 - 7	-	Father	H.
20	Machiner	9.30 - 7	-	At work	N.H.
20	Clerk	10½	-	-	N.H.

Age	Occupation	Hours of work.	Previous Institutional Treatment.	Sources of Infection.	
33	Laundry	6 - 7	-	Husband	N.H.
24	Confectioner	8 - 6	Cranbrook Home	Sister	N.H.
32	Nursemaid	7 - 7	S. Thomas'	-	N.H.
22	Domestic	13	Middlesex.	-	N.H.
24	Typist	8.30-5.30	-	Mother	H
17	Feather work	9 - 7	-	-	N.H.
18	Domestic	8 - 6½	-	-	N.H.
29	Clerk	8	Frimley	-	N.H.
20	Secretary	9 - 5	-	-	N.H.
17	Typist	10	-	-	N.H.
23	Laundry	6 - 6	-	-	N.H.
40	"	6 - 7	-	Husband	N.H.
23	Kitchenmaid	14	-	-	N.H.
23	Nursemaid	14	Brompton & Frimley	-	N.H.
18	Cashier	11	-	-	N.H.
18	Boxmaker	13	Vict. Ch. Hospital.	-	N.H.
38	Laundress	14	-	-	N.H.
25	Corset maker	13	Vict.Ch.	-	N.H.
24	Factory hand	12	S.Pancras Union Infir.	Brother	N.H.
17	Confectioner	14	T.B.Dispen:	Father	H.
33	Laundress	14	-	-	N.H.
23	"	14	-	-	N.H.
27	Sweet packer	10-12	-	Contact sister	H.
30	Laundress	9 - 7	-	? at work	N.H.

Age	Occupation	Hours of work	Previous Institutional Treatment.	Sources of Infection.	
23	Dressmaker	8.30-7.30	T.B.Dispen:	From another worker.	N.H.
31	Domestic	12	-	From children affected.	N.H.
38	"	12	Mt. Vernon.	-	N.H.
20	Hotel maid	6 - 10	-	Doubtful.	H.
21	Boot machinist	10-12	Bournemouth Sanatorium	-	N.H.
17	Typist	10	-	-	N.H.
39	Children's Nurse	10	-	-	N.H.
27	H. Maid	6.30-11.30	S.George's Hospital.	-	N.H.
25	Laundress	10	-	-	N.H.
31	Needlewoman at Frimley	10	Brompton & Frimley.	-	N.H.
17	Dressmaker	10	Gen: Hos:	From father	H.
30	Cocoa packer		T.B. dispen:	From father	H.
36	Secretary	10	Bowden	-	N.H.
23	Nurse	12	-	In phthisis ward Union Inf:	N.H.
20	Boxmaker	10	-	Mother & sister	H.
18	Packer	8 - 7	-	At work	N.H.
18	Waitress	8 - 9	S.Bartholomew's.	-	N.H.
17	Nursemaid	12	-	-	H.
23	Dressmaker	9 - 7	-	Brother	H.
19	Shop girl	10 - 12	T.B.Dispen:	-	N.H.
22	Machinist	8.30 - 7	-	-	N.H.
17	"	8⅓	-	-	N.H.

Age	Occupation	Hours of work	Previous Institutional Treatment.	Sources of Infection.	
21	Dressmaker	8.30 - 6	-	-	N.H.
24	Drug packer	8	-	-	N.H.
20	Domestic	6 - 7	-	Mother	H
23	Bottler	8 - 6.30	-	-	N.H.
21	Waitress	10	Brompton & Frimley	At work	N.H.
21	Domestic	10	-	Relatives	H
26	Machinist	11	-	-	N.H.
22	Domestic	7 - 8	-	Sister	H.
20	Nursemaid	10	Mt. Vernon	After measles	N.H.
19	Domestic	11	-	-	N.H.
27	Presser	11	T.B.Dispen:	Mother	H.
24	Machinist	10½	-	Relatives	H.
20	Clerk	9 - 6	-	-	H.
29	Housemaid	6.30-10	-	-	N.H.
33	Leather worker	8.30 - 7	City Rd. Vict.Ch:.	Relatives	H.
29	Domestic	7 - 5	-	"	H
27	"	12	-	-	H
18	Shop Asst.	12	-	-	N.H.
25	Tea packer	10	-	Father	H.
21	Waitress	11	T.B.Dispen:	Mother	H.
40	Domestic	12	-	-	N.H.
35	Dressmaker	9 - 8	-	-	N.H.
35	Shop Asst.	10	-	-	N.H.
21	Dusting in shop.	10	-	Sister	N.H.
24	Typist	7 - 8	Mt. Vernon	Sisters	H.
40	Sugar packing	10	-	Relatives	H.
17	Shop Asst.	10	City Rd.Hos:	Sister	H.
40	Nurse	10	-	-	N.H.

COMMENTS ON CASES.

The occupations in all these cases are indoor in an atmosphere rarely well ventilated. In ten cases the evidence was such as to lead to suspecting infection by aerial spread at work. In two cases the evidence was almost conclusive.

The circumstances in a great number were distinctly tending to the production of conditions of subnormal resistance to the disease.

The patients had continued their work in almost every case after the health was failing.

They were in most cases not recognised as tuberculous until long after their condition must have been evident to an expert clinician.

Their transference to sanatoria was delayed.

The extent to which they show predisposition and afford clinical evidence of infectivity has been referred to previously.

We may now consider the organisations which had provided treatment.

In sixty three cases the insurance doctor had sent the case direct to the tuberculosis expert for examination as to suitability for admission.

Ten came on the recommendation of the local tuberculosis dispensary.

In the remainder the practitioner had availed himself of the advice of the chest hospitals and in some cases of other sanatoria.

All these cases have had primary and one or more supplemental notifications.

By means of this organisation one hundred cases at the seedling stage have been discovered, notified and sent to a sanatorium where they will be arrested and cease to be foci of infection.

That is satisfactory for these cases for the present, but consideration will show that this only is a small step achieved in the process of prevention. Most authorities are agreed that for every case discovered and notified about nine more exist in the environment to which these cases will return.

A fresh crop of cases are already infected, some will recover without sanatorium treatment, some may recover without being detected, some will not be detected whilst such treatment is of much service and join the hospital cases to die or be discharged as incurable, a certain number will be similarly arrested.

Further infection will occur, arrested cases will occasionally become active again. The future of the present cases depends on organisations other than sanatoria.

The problem of prevention depends for successful

solution on the other agents in the scheme of prevention. Destructive criticism of the greater organisation still in a state of transition is undesirable.

It is better to suggest organisation of the existing agencies which could deal with the huge mass of tuberculous material the cases quoted has suggested.

The first necessity for organised work is correct diagnosis and adequate classification of cases.

D I A G N O S I S.

The requirements in this department of the scheme of prevention are early and exact diagnosis and the avoidance of error.

Early diagnosis cannot be over-estimated in the treatment of the disease.

This has been placed next in importance to the methods for the prevention of infection. As Philip said in his address to the British Medical Association, "Weed out the seedlings." It is not intended in this thesis to discuss treatment of the disease except from the administrative point of view, but from this point apart from the desire to cure individual cases, early diagnosis means limitation of possibilities of infection. It means economy and efficiency. How early diagnosis in administration may be best achieved will be referred to in other portions dealing with administration.

Diagnosis must be exact if treatment is to be efficacious and administration to be economically carried out.

Common errors of diagnosis must be avoided.

Diagnosis must be sufficiently exact to enable administration of treatment to be efficient and not wasteful. For this the central organisation requires

information of two kinds which must be considered in conjunction:-

(1) The condition of the lungs or other viscera affected with a reasonably exact description of the lesion.

(2) A description of the general condition of the patient in relation to the lesion and relation to the environment.

How this may be obtained, checked and classified with other cases for administrative purposes will be referred to in another portion of the discussion.

The common errors which lead to difficult administration may be briefly referred to.

(1) Diagnosis may be incomplete. Not only the nature of the disease, but its extent and the presence of complications require consideration. The existence of a cavity in one apex may be the result of old and arrested disease. The present illness may be due to recent affection of the opposite lung which might escape detection.

Laryngeal or other complications requiring special treatment should not be omitted, and should be described in their degree.

(2) Diagnosis may be incorrect to some degree through misinterpretation of physical signs though the disease is tuberculous.

Mistaking the results of old and healed tuberculous lesions for recent and active trouble is not uncommon.

The continued expectoration of bacilli may be in

some cases deceptive as to the activity of the process.

Squire has demonstrated that certain forms of bronchitis may be to some extent due to tubercle bacilli without dangerous affection of alveolar tissue and without a progressive lesion.

(3) Diagnosis of tuberculosis may be incorrect.

Haematemears may be regarded as haemoptysis.

Malignant disease of mediastinum or lung may receive incorrect interpretation.

Aneurism may be the explanation of the condition.

(4) Tuberculosis may be overlooked. The physical signs of bronchitis and emphysema may mark the signs of early pulmonary tuberculosis and the case therefore escape notification and treatment.

The next essential is suitable classification.

C L A S S I F I C A T I O N

The following classification fulfils the most clear demands for administrative purposes and is convenient for clinical description:

1. Pre-tuberculous.
2. Infected or contact cases, not presenting physical signs.
3. Early cases.
4. Sanatorium cases.
5. Hospital cases.
6. Chronic cases.
7. Incurable.

Classification is, however, difficult for the stages and varieties are subject to rapid change. However, from the administrative point of view, some such system is desirable. We shall refer briefly to the existing agencies which are best fitted to deal with each type of case. They will not be discussed from the point of their effectiveness in attempting cure but their value in prevention.

For the pre-tuberculous worker, the State has made itself responsible to some degree through the National Insurance Act and by adequate working, doubtless, prevention will occur. The Local Government Board will take a greater share in the prevention of unhealthy conditions

which predispose directly or indirectly to the spread of tuberculosis. In addition, the convalescent and rest homes might take a share in receiving cases as in New York where they are used under the term of Preventatoria.

Contact cases require supervision. This is as yet but partially organised.

This is probably one of the most important methods of prevention and probably the most neglected.

This matter is of the greatest importance, equally from the point of view of prevention and of cure.

These cases demand the skill which is described in discussing diagnosis, which is certainly too much to ask in the present day from all medical attendants acting under the present conditions. Skilled clinical advice is necessary from some central organisation. This work is, as yet, only systematically undertaken by the tuberculosis dispensaries. It will be further discussed in referring to the duties of that organisation.

Early cases will be sent to sanatoria, either directly through the Insurance Committee, or Poor Law or private charities and supply the clinician with the material with which he will have his greatest success. Others can, by organised domiciliary treatment at this stage, most efficiently be dealt with. This is also part of the work of the dispensary organisation.

Sanatorium cases, meaning those requiring such treatment for success, now have the option of Insurance Sanatoria and Poor Law Infirmaries. In many of the latter, excellent attempts are now made to provide adequate treatment.

Probably as progress is made, Guardians may see the real economy of providing treatment of this kind in adequate sanatoria. The provision of hospital wards by municipalities for infectious cases, has followed the recognition of the infectivity of the disease, and extended will greatly decrease infection. At present these are being dealt with somewhat tentatively under the Insurance Act, but their value is beyond doubt.

Chronic cases of varying infectivity can be patched in hospital wards but unless supervised, must continue to be sources of infection. In this the panel doctor will be only a partial help. It remains to the tuberculosis dispensaries and the Public Health Department, to supervise their precautions against infection.

It is for these cases that the increased development of colony treatment is most desirable.

Incurable cases, similarly, must be supervised and as may be necessary in case precautions are neglected, removed to wards either under municipal, charitable or Poor Law authority.

We have now decided what is the material to be dealt with and the organisations existing at present.

Taking the history and suggested subsequent progress of the cases quoted, we may attempt to suggest more complete organisation, which could effectively deal, not only with these cases, but the other material that they suggest.

O R G A N I S A T I O N

Let us assume that these organisations are efficient in their various methods, a review of the cases suggests that the organisations at present existing, are struggling with ill assorted cases. This is largely the result of extravagant claims having been made for special methods of treatment in the period when the success of prevention was supposed to lie in the cure of advanced cases. Now that the conception of the disease as an infectious one is being recognised, this must change. The whole outlook is altered. The most excellent success of methods of treatment is of small importance compared with the possibilities of success in prevention. The agencies providing clinical advice and treatment are reduced in importance to parts of the scheme of prevention. The greater organisation which will grow up around them organising and co-ordinating their efforts must regard eventually the number of cases treated as a measure of failure rather than success.

It must begin with a struggle to minimise poverty and reduce the untoward effects of what is not avoidable. It must prevent the cultivation of the soil suitable for the growth of tuberculosis by reducing the number of people susceptible by reason of conditions of subnormal resistance.

The influence of heredity will receive due and not exaggerated attention. But the power of the methods lies in the evidence that control of infection is possible. The idea that the bacillus is ubiquitous and virulent is disputed. Infection can be stopped at its source. The portals can be supervised, early cases must be caught.

But this means organisation much more perfect than at present. It is necessary for this purpose to have an organisation whose efforts will be more to co-ordinate existing agencies and supervise their tranference whose aim is to detect and classify.

In this respect the Tuberculosis Dispensary is in advance of State effort and organisation and the incomparable value of its work is assured. In these the careless consumptive is educated and the contacts are examined. In this respect it is superior to other institutions claiming recognition. In some cases municipal health authorities have conducted strict investigation as in the city of Manchester, where infected houses have been carefully investigated and contacts examined. But previous to the institution of the dispensary treatment, this has not been continued and complete. In

England, private enterprise usually precedes State administration, as in this case. The completer organisation must include such an agent, patient, flexible and persistent, with its purpose concentrated on prevention. At the present stage of development its duties are many. It requires to provide clinical and administrative experts, for the demands on diagnostic skill and administrative capability are beyond the present possibilities of private, charity or insurance practitioners. It is to prevent the waste of energy that arises from inco-ordinated efforts. It must accept the work that the official channels neglect.

The experimental and clinical evidence which have been quoted, promise success by supervision of the sources and methods of infection.

By these means combined with organisation of improved methods of treatment, a vast measure of success is assured. Research may add to our knowledge and to some degree to greater success in treatment.

Enough has been proved that Tuberculosis is a disease preventible by simple measures. Organisation will reduce the incidence to a degree comparable to success in allied infectious disease.

C O N C L U S I O N S

1. That Tuberculosis is a disease in a high degree preventible.

2. That success in prevention is to be more readily obtained by attacking the sources of infection than by the cure of cases.

3. That interference with the sources of infection is easy.

4. That success demands more complete co-ordination of the existing organisations.

B I B L I O G R A P H Y

Fowler & Godlee	Diseases of the Lungs.
Klebs	Tuberculosis.
Koch	The Present Position of the Crusade against Tuberculosis.
Newsholme	Prevention of Tuberculosis.
Osler	Practice of Medicine, Tuberculosis.
Philip	Prevention of Tuberculosis.
Powell & Hartley	Diseases of the Lungs.
Squire	Monograph on Influence of Heredity in Tuberculosis.
Walsham	The Portals of Infection in Tuberculosis.