

"SOME ASPECTS OF TUBERCULOSIS IN CHILDREN"

Thesis for the degree of M.D. 1920.

by

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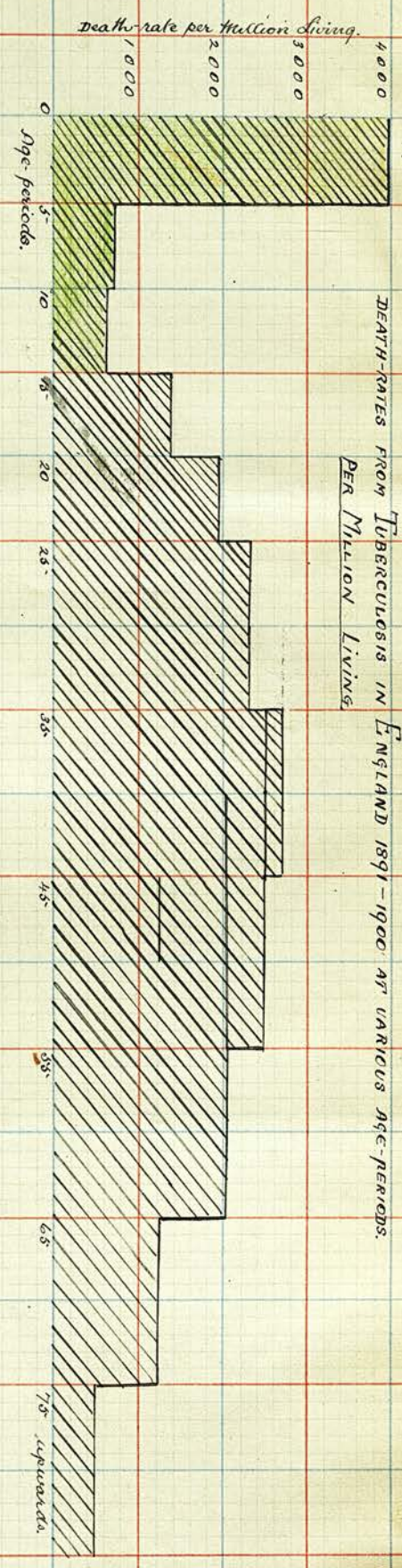
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"Yea, when I consider with myself how often in one year there is cause enough ministered for producing these Swellings, even to those who are wont to observe the strictest rules of living, I cannot sufficiently admire that anyone, at least after he comes to the Flower of his Youth, can die without a touch of Consumption". These words were used by Richard Morton in 1689 and, despite the immense advances made since that time in all branches of the Science of Medicine, they are as applicable to-day as they were two hundred and forty years ago. Tuberculosis still maintains its claim to the motto "Ubique" in spite of the fact that few diseases have evoked so much investigation from Physicians, Pathologists and Bacteriologists alike. At a time when Preventive Medicine is occupying such a deservedly large place in the thoughts of Statesmen and Doctors and, when the preservation of infant life is, after the ravages of war, of such vital importance to the Nation, Tuberculosis in children deserves from all the most careful consideration.

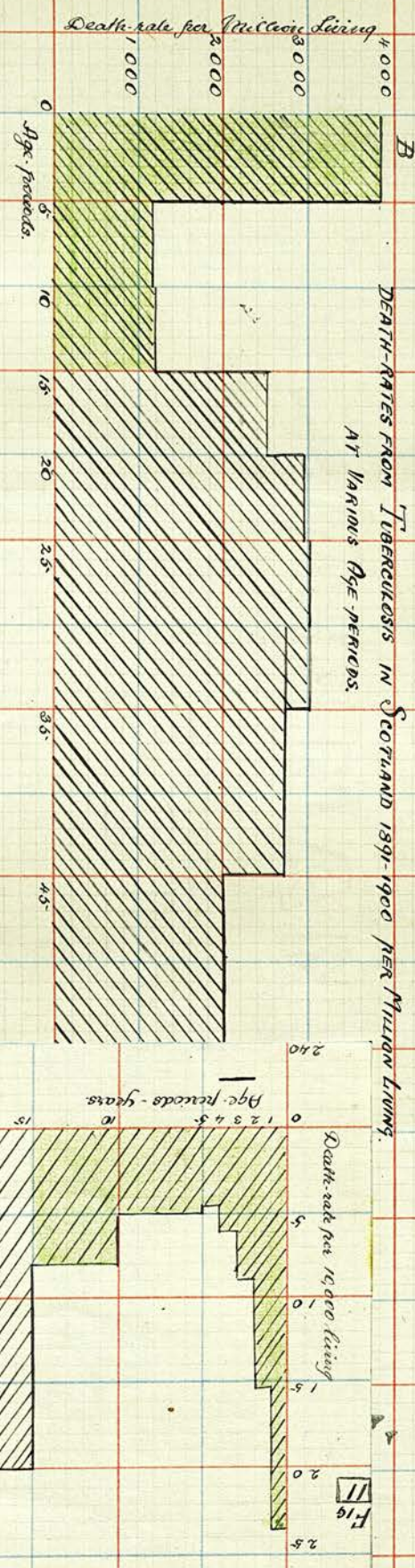
To give a comprehensive account of tuberculosis as it occurs in children is a task which could only be/

Fig D

DEATH-RATES FROM TUBERCULOSIS IN ENGLAND 1891-1900 AT VARIOUS AGE-PERIODS PER MILLION LIVING



DEATH-RATES FROM TUBERCULOSIS IN SCOTLAND 1891-1900 PER MILLION LIVING AT VARIOUS AGE-PERIODS



DEATH-RATES FROM TUBERCULOSIS IN SCOTLAND 1891-1900 PER MILLION LIVING AT VARIOUS AGE-PERIODS

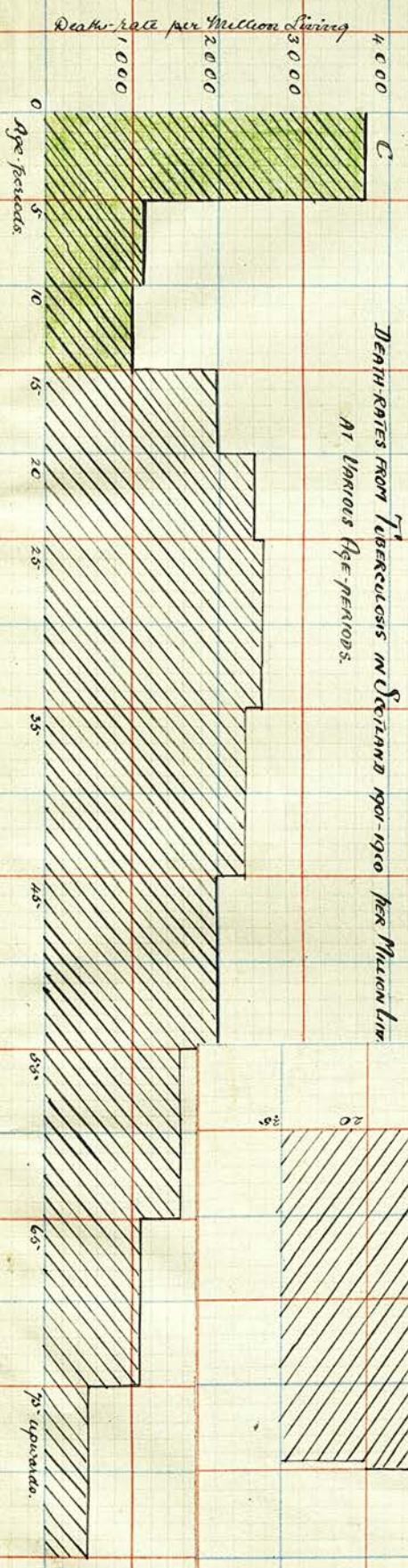


Fig E

Death-rate per 10,000 living at various age-periods

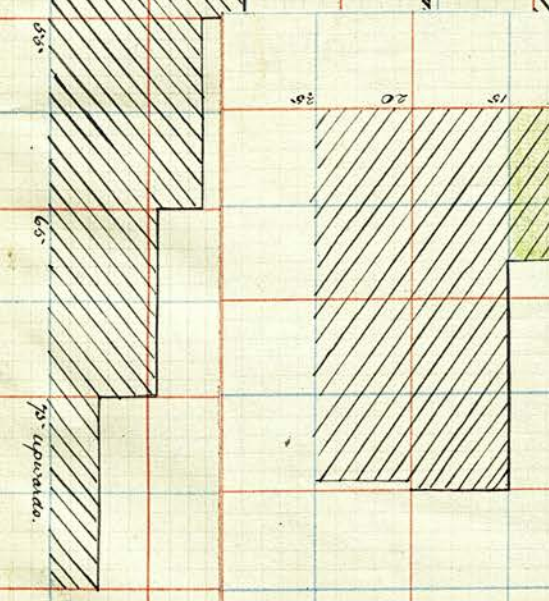
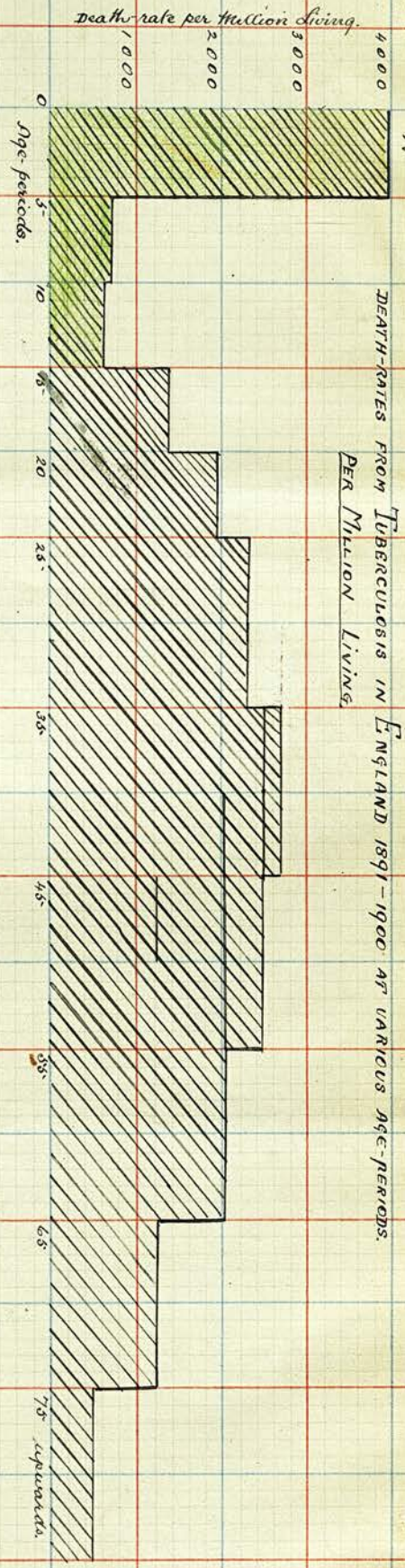
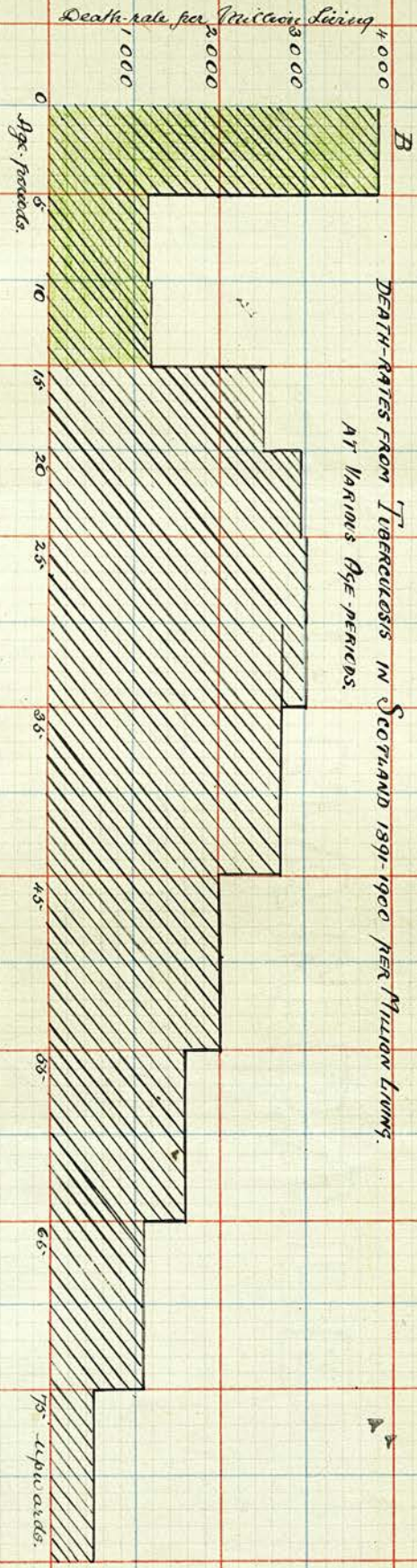


Fig 10

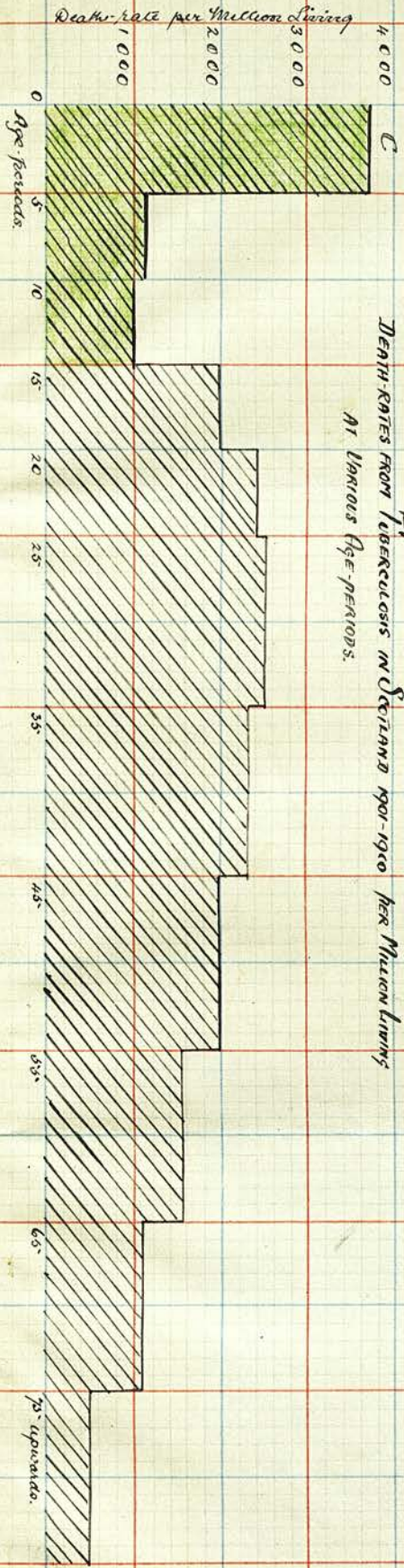
DEATH-RATES FROM TUBERCULOSIS IN ENGLAND 1891-1900 AT VARIOUS AGE-PERIODS.  
PER MILLION LIVING



DEATH-RATES FROM TUBERCULOSIS IN SCOTLAND 1891-1900 PER MILLION LIVING.  
AT VARIOUS AGE-PERIODS.



DEATH-RATES FROM TUBERCULOSIS IN SCOTLAND 1901-1950 PER MILLION LIVING.  
AT VARIOUS AGE-PERIODS.



be undertaken by one who commands a life-long experience of the disease. Such an attempt on my part would only end in disaster. I have attempted rather to collect facts regarding certain aspects of the disease and, while building for myself a foundation on which to set up a more complete understanding of the many problems which tuberculosis presents, to set down the results of my enquiries and such ideas as they suggest. Under these circumstances a lack of completeness, and of cohesion between the various parts, has been unavoidable.

#### MORTALITY.

A consideration of an analysis of the figures given in the Annual Reports of the Registrar-General, for the periods 1891-1910, 1901-1910 for Scotland and 1891-1900 for England, brings out these facts. Firstly, that the death-rate for the age period 0-5 years from tuberculosis is higher than at any subsequent age period and, secondly, that this high mortality is followed by a marked decline in the decade 5-15 years. The figures have been represented diagrammatically (Fig.I) and the part to which attention is specially directed has been shaded green. Fig.II is a diagrammatic representation of Hillenbergs table of death rates per 10,000 living in Prussia, at various/

various age-periods, for the year 1909 and also bears out the high mortality of infants and the subsequent decline in childhood.

Such figures assume a still graver aspect when consideration is given to the fact that many deaths reported as Bronchopneumonia, Bronchitis etc. would, without doubt, have been classed as Tuberculosis had a section been performed.

The high mortality from Tuberculosis in children is further borne out by the results of post-mortem examinations. In the Royal Hospital for Sick Children, Edinburgh, Shennan<sup>1</sup> found that of 1416 children, below the age of 14, who underwent post-mortem examination, no fewer than 562 or 36% either died from Tuberculosis or showed evidence of the disease, only 4% appeared in the latter category.  
<sup>38</sup> Still, Colman, and Carr found in 1279 post-mortem cases that 29%<sup>39</sup> died from Tuberculosis.

As the above post-mortem statistics are based on hospital experience, due allowance must be made for the facts that such hospitals receive the children of the poorer, more badly housed and fed classes, and that such a disease as tuberculosis from its severity in childhood is more likely to seek hospital treatment. Further, the exclusion from most hospitals of zymotic diseases/

diseases renders the above figures too high for general application.

#### MORBIDITY.

In regard to the morbidity of the disease  
<sup>1</sup> Shennan considers that, judging from post-mortem examinations alone, he would feel inclined to believe that practically all children infected with tubercle die sooner or later from that disease, as he finds a remarkable absence of traces of tubercle in children who die from other causes. This observation is not however borne out by the experiences of others.

<sup>2</sup> Lapage reports that as many as 50% of post-mortem cases in Manchester Childrens Hospital showed "Macroscopic and easily demonstrable tuberculous lesions".

<sup>4</sup> Morse in America gives 25-35% as his figure for the presence of tuberculosis in children under 15 years.

<sup>3</sup> Ganghofner, in 1800 autopsies on children dying from causes other than tuberculosis, found that 7.1% under 1 year, 16% from 1-2 years and 28% from 6-8 years showed evidence of tuberculosis. Other figures are given by Harbitz of Christiania who found that 42% of all children who died had tubercular foci while for Vienna and Paris, Hamburger and Sluka, and Comby put the figure at 40 and 38.5% respectively. On clinical grounds/

grounds alone Sir Robert Philip places the percentage as high as 30 in school children.

Post-mortem results then suggest the extreme prevalence of the disease, active or latent, but a more correct idea of the number of children infected may be gained from other lines of investigation.

It is now generally admitted that the tuberculin tests may be relied upon to indicate, in any given instance, the presence or absence of a tuberculous focus; that such a focus may be inactive is not to be denied but it is sufficient for my purpose to show that infection has taken place.

In 1000 children attending hospital or patients<sup>2</sup> in hospital, Lapage, employing the cutaneous test, found that during the age-period 0-2 years 32% gave a positive reaction and of these 14.7% were free from signs, symptoms or history of the disease. The frequency of a positive result increased until at the age-period 10-14 years no fewer than 60.8% were positive of whom 51.2% showed no signs, symptoms or history of the disease. Further evidence in support of these figures is found in the work of Hamburger<sup>6</sup> and Moliti who obtained, at a hospital for infectious diseases, a positive result in 50% of cases.

<sup>7</sup> McNeil for the age-period 0-1 year found 14.1% positive/

positive and that the frequency of a positive result increased to 55% for the age-period 11-14 years. Still more impressive is his figure of 59.4% found in an examination of 170 industrial school boys, clinically free from disease, between the ages of 6 and 16 years. These figures have been substantiated and confirmed by Mantoux<sup>11</sup> for Paris and Nothmann<sup>12</sup> for Dusseldorf.

Such figures could be almost indefinitely multiplied but those quoted are sufficient to show that when the age of puberty is reached about 55% have already been infected with Tuberculosis and further that the number infected varies directly with the age of the child. This figure probably underestimates the prevalence of the infection as will be seen when the tests are more minutely considered and as Pritchard<sup>13</sup> suggests, the popular German saying "am Eude hat jeder Mensch ein Bischen tuberculose" might almost as truthfully read "von Aufaugen hat jeder Mensch ein Bischen tuberculose".

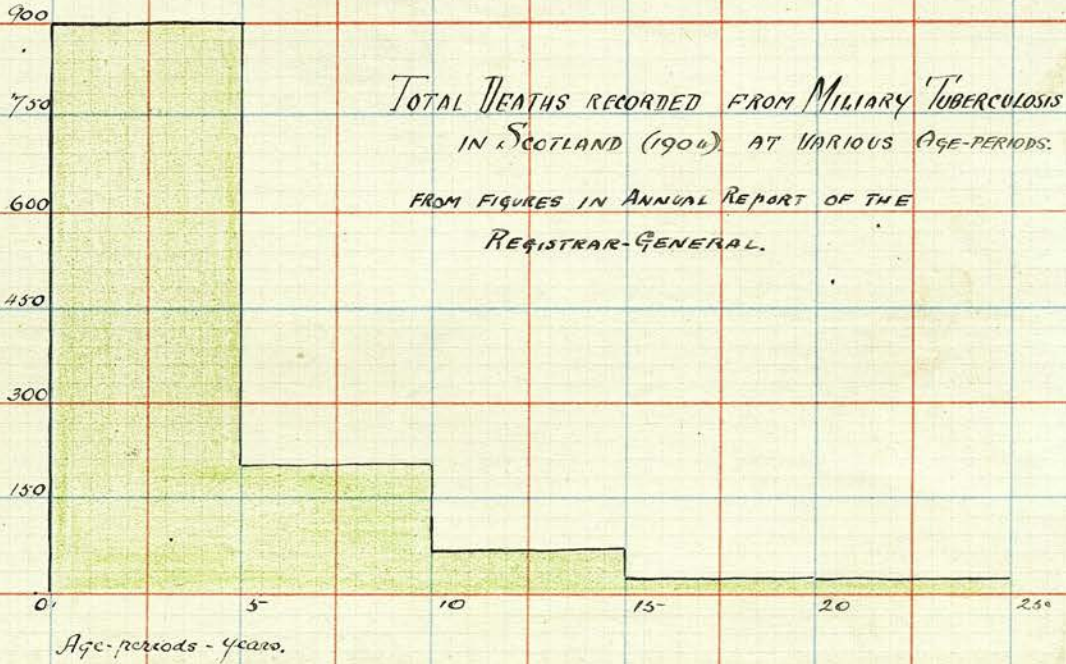
#### MODE OF SPREAD.

In correlating, then, the mortality and morbidity we see that as the number of children infected increases the mortality diminishes.

The/

Fig  
④

TOTAL DEATHS RECORDED FROM MILIARY TUBERCULOSIS  
IN SCOTLAND (1904) AT VARIOUS AGE-PERIODS.  
FROM FIGURES IN ANNUAL REPORT OF THE  
REGISTRAR-GENERAL.



The explanation of this apparently paradoxical statement would seem to be, that an infection, which is insufficient to overwhelm the child or even to produce recognisable signs and symptoms, is of value in raising the resistance of the protective mechanism to prevent a further spread and to overcome a fresh infection. That this a a correct explanation is borne out by the fact that in infancy tuberculosis tends to become generalised at an early stage of the disease, (see fig.IV which represents the total deaths recorded in Scotland from Military Tuberculosis, for 1904, at various age-periods) while later in childhood, the resistance of the protective mechanism having increased, the glandular picture occupies the prominent position along with a more localised blood or lymphatic spread to lungs, bones, joints etc. The process might be summed up by saying that there are three stages which may be represented in a case of tuberculosis.

1. Glandular Infection.
2. Spread to other organs varying in extent but never so great as
3. Generalised blood infection.

In the infant stage three is reached after a brief and often unrecognised first stage. In the child stage/

stage one predominates, stage two is frequently seen, and stage three may form the terminal phase.

As illustrative of these three stages I quote, in parts verbatim, the summary of the post-mortem findings in a case described by Professor Lorrain Smith.<sup>22</sup> The case was that of a boy aged nine who had been in failing health for three years. The mediastinal and bronchial glands were calcified and formed the nidus of the original infection, this is to be regarded as stage one. Stage two shows a spread from the original foci and the formation of new centres of tuberculosis in lungs, hip joint, and suprarenals also by sputum to the intestine and larynx. The third stage is represented by a Military spread to liver, spleen, peritoneum and, while the symptoms were suggestive of meningitis this could not be verified as permission to examine the head was not granted. Professor Lorrain Smith concludes by saying "the consideration of this case, as the gradual development of a local into a general infection, enables us to obtain a fairly complete picture of the progress of tuberculosis."

SOURCES OF INFECTION.

The discovery in 1882 by Koch of the tubercle bacillus gave the proof of the infectivity of tuberculosis and, by the finding of the bacillus in the discharges and secretions of tuberculous patients and tuberculous cows, the sources of infection were demonstrated. Other animals also suffer from tuberculosis but the part they play in transmitting the disease to children is negligible.

In regard to bovine infection in human beings, although this was denied by so great an authority as Koch in his address to the British Congress of Tuberculosis in 1901, it is now recognised by all authorities that it occurs with comparative frequency and that milk is the main vehicle. Muscle is rarely the seat of tuberculosis and even contaminated meat is of small importance on account of the fact that it is sterilised in the process of cooking. When it is realised that tuberculous milk may come from tuberculous cows even when the udders are not affected, the importance of this source of infection will be realised. Mitchell shows that, in Edinburgh, for the thirteen years ending 1912, an average of 24 cows had annually to be removed from the city byres on account of tuberculosis and that this figure cannot be taken/

taken to represent the total number of cows affected. Of 65 cases of bovine tuberculosis in children which he has investigated two thirds of the cases had been fed on unsterilised cows milk since birth and in no case out of the 65 was there a family history of tuberculosis. Kenwood and Parkes quote veterinary authorities in placing the incidence of tuberculosis amongst dairy cows kept in towns as high as 25%.

<sup>26</sup> Moore speaking of tuberculous glands is also impressed with the importance of milk as the vehicle of infection and notes that in a series of 20 cases he was unable, in any instance, to trace the infection to cohabitation with a phthisical relative. Reference must be made of a case reported by Whitla where 15 out of 150 previously healthy girls developed tubercular cervical lymphadinitis and of six cows supplying them with milk, although ideally housed etc, four were found to be tuberculous while in only one were the udders diseased. Osler quotes Hess as showing that 16% of milk specimens examined in New York contained tubercle bacilli.

The human type of bacillus reaches the child from the discharges of the tuberculous parent, nurse etc. It is mainly from the sputum that infection arises. The organism may remain virulent in dried sputum/

sputum for as long as two months and, becoming mixed with dust, permeate the atmosphere of the badly ventilated house or the dust may be conveyed to the mouth under the nail of the crawling infant, or again contagion may be direct as in the act of coughing or kissing. Apart from sputum the bacilli may appear in the urine of genito-urinary cases or in the faeces from swallowed sputum and active ulceration of the intestinal wall.

Observers are at variance as to the relative frequency of the two infections in childhood but I think it must be admitted that the bovine infections occur as frequently, if not more so, as the human.

18

Mitchell in 72 cases of tuberculous lymphadinitis found the human and bovine bacilli in 7 and 65 cases

25

respectively, while Fraser, investigating 70 consecutive cases of operation on tuberculous bones and joints, found that a bovine infection accounted for 60% and the remainder, 40%, were due to the human bacillus. I add a table of the figures given by

40

Park and Krumwildi of their experience of the percentage incidence of bovine infection in various types of the disease at different ages.

Diagnosis	Adults 16 & over	Children 5-16	Children. under 5
Pulmonary Tuberculosis	0.0	0.0	4.1
Tuberculous Adenitis (cervical)	3.6	36.6	58.0
Abdominal Tuberculosis	22.0	46.0	59.0
Generalised Tuberculosis	2.7	40.0	23.0
T.B. Meningitis with or without generalised lesions	0.0	0.0	13.6
T.B. bones and joints	3.5	7.3	0.0

I wish, further, merely to mention the seductive theory of the development of the disease in adults, put forward by v. Behring in his address at Kassel (1903), which, although proof is lacking, serves to emphasise the importance of tuberculosis in childhood. He expressed the opinion that infection takes place in infancy or childhood and remains latent until the powers of resistance of the patient becomes impaired. The disease then becomes active. The tubercle bacilli are introduced, usually in cows milk, and get absorbed into the system through the intestine. He had to admit, however, that the human type of bacillus which/



the subject is immense. The presence or absence of a local lesion in the mucous membrane is no guide, as it has been shown by Griffiths and others that tubercle bacilli may pass through intact mucous membrane.

The portal of entry may sometimes be judged by the age of the lesions in the glands guarding the portal but it is evident that a lesion in the bronchial glands, for example, may have arisen from an ascending infection of the intestine, a descending infection from the cervical glands, or as a more direct infection from the lung. Further, when the progress of the disease has been rapid, the lesions throughout a chain of glands may show no features by which a difference in age of the lesions may be judged. It is probably wisest to steer a middle course and, while agreeing that a direct affection of the lungs occurs and that a spread through the intestine is probably frequent, to lay particular stress on the importance of the regions common both to air and food borne infection. I refer to the regions comprised by the pharynx, nasopharynx, nasal and buccal cavities. Remembering the frequency with which these regions are the seat of catarrhal processes, the frequency with which the glands draining these regions are the seat of tuberculous disease can hardly be surprising.

Sir/

34

Sir Robert Philip believes that while the whole stretch of mucous membrane is vulnerable perhaps the most vulnerable point is the tonsillary region. He further points out that while cervical tubercular lymphadinitis is frequently before the Physician and Surgeon, these cases are cases of gross pathological change and that more subtle and insidious, but none the less pernicious, evidence of the disease can be found, if examined for by careful palpation, in the region of the cervical glands. In this connection

<sup>36</sup>  
Latham in 45 consecutive autopsies on children, from 3 months to 13 years of age, found 7 cases of tuberculosis of the tonsils.

<sup>37</sup>  
Walsham found tonsillary tubercles in 21 out of 34 cases of tuberculosis and in several he considered the tonsillary lesion primary.

<sup>1</sup>  
Shennan in 111 cases of tuberculosis in children undergoing post-mortem examination found tuberculous tonsils in 9.9% while the cervical glands were caseous in 25.2%.

It is not to be denied that tuberculosis of the tonsils may arise from the regurgitation of sputum from a primary lung focus but, considering their direct accessibility to both inhaled and ingested tubercle bacilli, it seems reasonable to maintain their importance as a portal of entry of the bacillus.

UNITY OF THE DISEASE.

From what has been said regarding the character of tuberculosis in children it must be seen that, in considering, for example, a case of hip joint disease, one is merely looking at a visceral manifestation of a more wide spread infection. A division of tuberculosis into such classes as medical and surgical, besides being unscientific, sacrifices the unity of the disease. It is from the broad aspect that tuberculosis must be regarded, and the tendency to consider the visceral manifestations as a purely local disease combatted.

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DIAGNOSIS.

The recognition of active tuberculosis in children is a matter which may be comparatively simple, as in tubercular disease of the hip joint, or it may be so fraught with difficulties that in the end it is impossible to say more than that its presence is a probability. It is not intended here to enter into an exhaustive discussion of the diagnosis of the various visceral manifestations of tuberculosis but to deal with the disease as an entity in considering only the reactions, and history, which may be of value in aiding the recognition of active disease or suggesting its presence.

I wish, first, to review the various tests which have been applied to the diagnosis of tuberculosis and to form an estimate of their value. I shall consider them in the following order.

(1) Cutaneous Tuberculin Tests.

(a) Cutaneous Test (v. Pirquet.)

(b) Quantatative Cutaneous Tests.

(c) Ophthalmic Test. (Calmette)

(d) Inunction Test. (Moro)

(2) Subcutaneous Tuberculin Test.

(3) Fixation of Complement.

(4) Opsonic Index.

CUTANEOUS TUBERCULIN TEST.

This test was<sup>2</sup> introduced by v. Pirquet in 1907 and was based on the fact an animal infected with tuberculosis became sensitive to the application of tuberculin to punctures made in the skin.

The test is performed by placing two drops of full strength Koch's Old Tuberculin, three inches apart, on the front of the forearm; this was shown by Schutz<sup>6</sup> and Videky to be the most sensitive skin area. The blunt end of a darning needle may conveniently be used to make three punctures, by pressing and rotating the needle into the skin. One puncture, a control, is midway between the drops and the others are made through the drops. Blood should not be drawn, but, as in vaccination against smallpox, only the skin lymphatics are opened. Excess of tuberculin may be wiped off and the remainder allowed to dry into the punctures.

Many modifications of the method of procedure have been proposed (Holt,<sup>3</sup> McNeil<sup>4</sup>) but offer no advantages. In a positive case a reaction occurs usually in<sup>23</sup> 24<sup>24</sup> hours and has been classified and described by Hamman<sup>5</sup> and Wolman as follows:-

- (1) Negative - no appreciable difference between the reaction and the control.
- (2) Slight reaction - definite redness with some infiltration.
- (3)/

- (3) Reaction - wider area of redness with definite raised centre.
- (4) Reaction - wider area of redness and more marked infiltration than
- (5) Reaction - unusual redness and wide area of infiltration. All cases which go on to vesication. They further attempt to draw conclusions from the character of the reactions and divide them into premature, persisting, late, cachetic and scrofulous, but the introduction of such great sources of personal error in observation must mitigate against accurate interpretation and it will be seen, when considering the quantitative test, that the violence of the reaction depends as much on technical points in the carrying out of the test as on the state of the disease.

In the general application of positive and negative results to diagnosis, v. Pirquet found that 88% of the tuberculous reacted while 12% failed to react and of the apparently healthy 16% showed a positive result. The figures have been confirmed by/

by Gaughofner, Muller, etc. Those tuberculous patients who fail to react belong to one of three classes

- (1) Rapidly progressing tuberculous cases.
- (2) Cases in terminal stages of chronic tuberculous disease.
- (3) Case suffering from other acute infections, especially when they are fatal.

In classes 1 and 2 the negative result would appear to be due to the fact that such cases are overwhelmed by the amount of tuberculin already in circulation and have not the power of reaction. This is borne out by the experiments on rabbits of Calmette, Breton and Petit, who found, in the case of the ophthalmic test, that a moderate dose of tuberculin provokes a response while a lethal dose has no such effect.

The stumbling block in the path of the diagnosis of active disease by this test is the number of apparently healthy people who give a positive reaction. Riviere places the percentage of all children who react as high as 90%, Mills at 95%, so it is obvious that a positive result in older children cannot, of necessity, be considered an indication of active disease. In infancy, however, up to 1 year, when morbidity/

morbidity is almost synonymous with mortality, a positive result is of considerable diagnostic importance. <sup>21</sup> March found that a positive reaction below the age of one invariably meant a fatal result. Calmette, <sup>12</sup> Geyssez and Letulle report observations on 1226 children at Lille and the results are tabulated as follows:-

Under 1 yr.	273	children	exam <sup>d.</sup>	of whom	8.7%	were	positive.
1 - 2 yrs.	145	"	"	"	22.1%	"	"
2 - 5 "	206	"	"	"	53.8%	"	"
5 -15 "	366	"	"	"	81.4%	"	"
Over 15"	236	"	"	"	87.7%	"	"

They note that estimated according to the death rate from tuberculosis in Lille only 24% of these children are destined to develop manifest tuberculosis. It must be obvious therefore that there is nothing in the results of this test which can be considered as specifically diagnostic of active disease. Bruce <sup>13</sup> Leckie investigating the problem obtained results which were so uncertain that he came to the conclusion that the cutaneous reaction was of no diagnostic value.

Other observers have made an attempt to utilise the cutaneous reaction in another direction. <sup>14</sup> Gauvain using tuberculin from human and bovine sources attempted to differentiate between a human and a bovine/

bovine infection by the violence of the reaction to the respective tuberculins. From the following results he concluded that a differentiation by this means was impossible.

Result of Reaction	Number of Cases	Bacteriological Findings.			
		Human	Bovine	Atypical	Negative
Approximately equal	23	16	5	1	1
Human slightly greater	21	13	8	-	-
Bovine slightly greater	25	14	6	1	4
Human much greater	4	2	1	-	1
Bovine	7	5	2	-	-
	80	50	22	2	6

#### QUANTATIVE CUTANEOUS TEST.

It was thought that if a means could be adopted whereby the minimal dose to evoke a response could be accurately gauged, a definite diagnostic limit of sensitiveness might be fixed for the latent and active groups. Erlandsen and Ellermann introduced a method which/

which was based on the assumption that, where the stimulus (Tuberculin) varied in geometric progression, the response, measured by the diameter of the papule, would vary in arithmetical progression.

On the front of the forearm, which has been cleaned with ether, are drilled, as in the v. Pirquet reaction, five holes one inch apart. The distal puncture is a control and into the others is dropped, in ascending order, 1%, 4%, 16% and 64% old tuberculin. After two minutes the excess of fluid is removed with cotton wool and the remainder allowed to dry. After 24 and 48 hours the diameters of the resulting papules are carefully measured with calipers. The average size, measured in millimeters, at the two examinations, together with average difference in size of the papules, allows the sensitiveness of the patient to be calculated from a table <sup>11</sup>. (If the patients minimal reaction strength of tuberculin is 1%, he is said to have a sensitiveness of 100, if 16% his sensitiveness would be 6.25 and so on).

This method, as has been shown Schutz and Videky, <sup>6</sup>  
<sup>18</sup> Kogel and <sup>19</sup> Sachs, is open to certain fallacies. They point out that the reaction varies in time of development, with the site employed, amount of tuberculin, length of time of application and depth of scarification. These/

These difficulties are partly overcome by taking the average size on two days, always employing the same site, and applying the tuberculin for a definite length of time. But in the face of such sources of error it must be seen that great care is necessary in the carrying out of the test and even then it is admitted (v. Pirquet)<sup>22</sup> that unexplained discrepancies may arise. It should also be noted that Kogel fails to find a constant arithmetical increase in the size of the papule.

<sup>20</sup>  
Ellis introduced, under the name of the Multi-papillary Cutaneous Method, a modification of the above by which he grouped his patients in four categories. He employed old tuberculin 1:10, 1:100, 1:500, 1:1000, 1:10,000 and P.T.O. His groups were:-

- (1) Hypersensitive - reacting markedly to over 1:500.
- (2) Sensitive - acting similarly to 1:100.
- (3) Subsensitive - reacting below 1:100
- (4) Insensitive - giving slight or no reaction.

The Army Medical Board adopted a sensitiveness of 100<sup>1</sup> as indicative of active disease. McManus agrees with this and thinks that a sensitiveness of 10 points to an old quiescent centre "of no clinical importance".

<sup>11</sup>  
Riviere gives 40 as the standard of active disease,

<sup>16</sup> <sup>10</sup>  
Moreland 50, while Hamman and Wolman found that 16% of clinically non tuberculous patients had a sensitiveness of/

of 100 or over and that among cases of incipient phthises 44% were less than 100 while no less than 22% were less than 20. In view of such erratic results it is obvious that the groups of active and latent disease cannot be separated by measure of their sensitiveness, but it would seem that a sensitiveness of 500 or over is, at least, suspicious of active disease.

THE OPHTHALMIC REACTION.

This test was described almost simultaneously by  
<sup>25</sup> Wolff-Eisner and <sup>26</sup> Calmette in 1907. To commence with  
 a 10% solution of alcohol-precipitated tuberculin was  
 used but this was reduced to a 1% solution by Calmette.  
<sup>5</sup> Hamman and Wolman recommend a 1% solution of old  
 tuberculin in normal saline.

After inspection has shown the eye to be free  
 from disease and a comparison has been made between  
 the two eyes, one drop of a 1% solution of old tuber-  
 culin is placed in the conjunctival sac. The lacry-  
 mation of crying children invalidates the test.  
<sup>27</sup> Baldwin devised a pipette to measure the drop accur-  
 ately, but this is unnecessary. The instillation  
 should be made in the morning so that the eye can be  
 observed throughout the day. The reaction commences  
 in 5 to 6 hours and is usually well marked in 24 hours.  
<sup>28</sup>  
 It shows itself as a definite palpebral redness with  
 increased secretion and photophobia. If the test is  
 negative <sup>39</sup> Bandelier and Roepke repeat the test in the  
 other eye with a 4% solution. The test should not be  
 employed if a future course of tuberculin appears  
<sup>40</sup>  
 likely as this may light up the reaction. Various  
 degrees of reaction have been described by Eyre, Wedd  
<sup>29</sup> and <sup>30</sup> Hetz, <sup>10</sup> Letulle, Hamman and Wolman, but no deductions  
 can/

can be based on such differences.

The results obtained by Baldwin and Calmette are tabulated below.

Observer	Tuberculous		Suspected		Unsuspected	
	Number of cases tested	% of Cases giving +	Number tested	% +	Number tested	% +
Calmette	2894	92%	1081	57%	391	16.8%
Baldwin	310	70%	265	36%	185	18.3%

It must be seen that ~~the value of~~ a positive result as indicative of active disease is not specific although it adds to the sum of probabilities.

<sup>38</sup>Latham in speaking of the Calmette and v. Pirquet reactions says "it cannot be urged too strongly that a positive tuberculin reaction merely shows the presence of a tuberculous lesion; it does not by itself help us to differentiate between active and inactive tuberculosis.....".

The test has the advantage of being easily <sup>33</sup>applied and, although such authorities as Wolff-Eisner, Baldwin etc. consider it safe, others oppose it owing to the liability of producing conjunctivitis, ulceration, and keratitis (<sup>36</sup>Schrumpf, <sup>35</sup>Collin, Krause and <sup>34</sup>Hertle, <sup>37</sup>Brown ).

INUNCTION.

The method of employing the cutaneous test by inunction was introduced by Moro in 1908.<sup>41</sup> He recommended the use of a 60% ointment of old tuberculin in Lanoline. A small piece the size of a pea, is rubbed into the skin for one minute over a definite area measuring five square centimeters. The abdomen is the site usually chosen for the inunction. In 12 - 24 hours there is a red discolouration of the skin and papules may appear varying in size from a pin head to several centimeters in diameter. In some cases the reaction may be delayed for 6 - 8 days. As a rule, however, the reaction has subsided by that time leaving only a temporary brownish discolouration of the skin. In a moderately severe reaction there may be ~~some~~ itching, and pigmentation lasting for some weeks may result. I tabulate below the results obtained by various observers.

Observer	No. of Cases Examd.	Tuberculous		Suspected		Unsuspected.	
		No. of Cases	% +	No. of Cases	% +	No. of Cases	% +
Moro	Child- ren. 1034	178	85%	450	73%	406	12.5%
42 Patterson	Adults 171	111	80%	28	14%	32	37%
43 Webb	Adults 141	27	70%	39	79%	85	22%

44

Wolff-Eisner has shown that the results of the test vary greatly with the time occupied in rubbing and the thoroughness with which the rubbing is done.

A consideration of the above figures shows that an average of 23% of healthy persons give a positive result which demonstrates the inability of this test to answer the question is the child suffering from active tuberculosis. A positive reaction is in favour of tuberculosis but quite a definite proportion of apparently healthy people react and any deductions based on a positive result must conform with the other aspects of the case.

The various cutaneous tests just described show a considerable degree of conformity in their general results and little or no distinction can be drawn between them in estimating their value in diagnosis. Were it a case of deciding if a person had ever been infected with tuberculosis the answer given by the tests would be comparatively reliable and allowance would only have to be made for those cases suffering from widespread tuberculosis or other acute illnesses. As in infancy, the numbers infected and the numbers developing active disease approximate very closely, a positive result, almost without doubt, means active disease/

disease. Thereafter, the importance of a positive result must vary inversely as the age of the child, and must form no more than a link in the chain of evidence on which the diagnosis of active disease is based. A negative and especially a repeatedly negative result is of more value, as, excluding obvious serious disease, it renders a diagnosis of tuberculosis almost unwarranted.

#### THE SUBCUTANEOUS TUBERCULIN TEST.

The tuberculin used may be either Koch's old tuberculin or albumose free tuberculin. Latham <sup>38</sup> considers that the T.A.F. is more satisfactory, as, containing only specific proteins, it does not lay itself open to the objection that an anaphylactic response to non-specific proteins may enter into the reaction.

Koch's original dosage was 1 milligram, 5 milligrams and 10 milligrams <sup>46</sup> repeated if no reaction occurred. <sup>47</sup> Hutinel in France, and Pickert in Germany, were the first to suggest smaller doses, a plan further elaborated by Lowenstein and Rappaport <sup>48</sup> who gave 0.2 milligram repeated, if necessary four times, at intervals of three days. In this way it was shown that, as some cases responded only to the third or fourth/

fourth dose, with repeated doses a patient was rendered  
 more sensitive. With this dosage, however, Hamman<sup>49</sup>  
 and Roepke<sup>50</sup> found that many definite cases of tubercu-  
 losis failed to react. Roepke and Bandelier<sup>39</sup> recommend  
 0.2 milligram, 1 milligram, 5 milligram and 10 milli-  
 gram for adults with half this for children and this is<sup>11</sup>  
 the plan most often followed. (Riviere, Hamman and  
 Wolman,<sup>5</sup> MacManus,<sup>1</sup> Latham,<sup>38</sup> Inman.<sup>52</sup>)

The reaction is usually evident in from 12-24  
 hours but, as occasionally it may be delayed from  
 36-48 hours, it is wisest to allow three days to elapse  
 between each injection. The site chosen for the  
 injection varies but, as a rule, some part where the  
 skin is lax will be found most suitable as less dis-  
 comfort and pain are produced in lax tissue from the  
 local reaction. Veins must be avoided.

Prior to the injection the patient should be kept  
 at rest for three or four days to reduce the possibility  
 of autogenous tuberculins being carried into the  
 circulation and, further, a three or four hourly  
 temperature chart should be kept so that the mistake of  
 giving a febrile patient tuberculin may be avoided  
 while subsequent deviations may be interpreted in the  
 light of <sup>the</sup> normal range of the patient.

Tuberculin has, at various times, fallen into  
 disrepute/

disrepute owing to accidents which have usually resulted from insufficient consideration of the dosage, technique and contra-indications. (Bandelier and  
 39            11            55            57            56  
 Roepke, Riviere, Junker, Otten, Romberg and many others).

Riviere notes the contra-indications to be:-

(1) Fever (above 99.8, rectal, at any time during observation).

(2) Obvious Phthisis - especially with secondary infection.

(3) Recent Haemoptysis; suspicion of miliary tubercle; recent severe illness; serious disease such as diabetes in the young; kidney disease; myocarditis and also  
 101  
 epilepsy.

Mackay considers that it should not be used in tuberculosis affecting the eye as the increased exudation may impair the structure of the eye.  
 102

Norton considers the tuberculin tests of little practical use being unreliable or dangerous. Other authorities have expressed grave warning as to the possible results. I add two quotations. Sir R. D.  
 45

Powell says: "I would gravely question the propriety and safety of using the tuberculin test at all freely for doubtful cases. A person or a child may be quite well and yet have the centre of inert tubercle within him. A large percentage of the population at the present time would react to an efficient dose of tuberculin/

tuberculin, but it is not wise to raise the devil in order to reduce him to harmless inaction afterwards. It is better to leave him to his innocent slumbers and amend circumstances favourable to his dire awakening".

Writing on the same subject, Sir T. Clifford Allbut<sup>53</sup> says "It (tuberculin) may do no harm in a focus already not inactive; it may even modify it in some favourable way; but what about some other focus dormant and unsuspected on the way to adolescence?"

In spite of such grave warnings I feel that the bulk of evidence on the subject goes to show that, in the hands of experts, the test can be used with confidence.

The reaction produced by the subcutaneous injection of tuberculin may be divided into three component parts.

1. Local Reaction.
2. General Reaction.
3. Focal Reaction.

The Local Reaction may be dismissed, as its significance is similar to the v. Pirquet reaction, but, unless marked, more difficult to determine.

The General Reaction, consisting of an elevation of temperature, malaise, slight headache and anorexia, makes its appearance in 12-24 hours. The reaction varies in severity but there is no evidence to show that/

that its severity bears any constant relation to the activity of the underlying diseased processes. It is recognised that fever may be produced in a non-tuberculous patient if the dose is sufficiently large and observers differ as to the size of the dose which may be considered specific. Gordon by injecting chemically pure tuberculin obtained no febrile reaction unless secondary to a focal reaction in the diseased tissue and recommends giving up the consideration of the febrile reaction in favour of a focal reaction in diagnosis.

Beck working in Koch's Institute records the results of 2508 cases upon whom the test was performed. In 378 cases of tuberculosis all reacted while in 338 cases of suspected pulmonary tuberculosis 298 reacted. He obtained a high percentage of reactions in other diseases:-

Gonorrhoea	106 tested	59 reacted
Gastric Ulcer	15 "	10 "
Erysipelas	121 "	59 "
Syphilis	143 "	59 "

Fraukel in 200 cases obtained the following results:-

Tuberculous		Suspected		Unsuspected.	
No. of Cases tested	% +	No. of Cases	% +	No. of Cases	% +
56	100%	76	92.1%	68	56.1%

The/

The high percentage of positive reactions in apparently non-tuberculous people mitigates against the value of the test for discovering active tubercle.

FOCAL REACTION:-

If a visible lesion such as Lupus is carefully watched during the exhibition of tuberculin, it is found that a reaction occurs in the diseased area consisting of hyperaemia, swelling and increased secretion. This is the focal reaction.

In areas where the disease cannot be observed by the eye, the focal reaction may make its presence felt in other ways. In a joint, for example, there may be increased pain and rigidity; in the chest there may be increased cough, breathlessness, sense of oppression and increase of sputum but more important still is the increase or change in the physical signs, such as an increase in the area of dullness or in the number of râles. The detection and estimation of this change presupposes a careful examination prior to the inoculation and a reconsideration of the signs when the reaction occurs. Inman calls attention to the fact, that, in the eye in which tuberculin has been instilled, a reaction may be caused by a subsequent injection of tuberculin and so argues that a focal reaction in the lung only means the presence of/

of a tuberculous process and gives no indication as to its activity or inactivity. On the other hand such observers as Latham,<sup>38</sup> Bandelier<sup>39</sup> and Roepke, Hamman and<sup>5</sup> Wolman,<sup>11</sup> Riviere and many others consider a well marked focal reaction as diagnostic of active disease.

The frequency with which a focal reaction is obtained varies. †. Romberg<sup>56</sup> in an examination of 324 cases of tuberculosis obtained the following results.

Focal and General reactions present	60.8%	cases
Focal reaction alone	" 7.4%	"
General " "	" 23.5%	"
No reaction	" 8.3%	"

<sup>60</sup>Walterhofer in 110 cases of active tuberculosis found a focal reaction in 54.5%.<sup>61</sup> Muller and Kayserling<sup>62</sup> found it in 35% of their cases and Junker in 10% of his cases.

Although, then, most authorities agree as to the value of a positive focal reaction in diagnosis, its presence is not constant and its absence does not exclude active disease.

FIXATION OF COMPLEMENT.

The possibility of employing a reaction, similar to the Wassermann reaction in Syphilis, for the diagnosis of Tuberculosis was suggested in 1913 when Bordet and <sup>63</sup>Genou demonstrated, in the serum of tuberculous patients, the existence of antibodies capable of fixing complement in the presence of tubercle bacilli.

Such observers as <sup>64</sup>Wolff and <sup>65</sup>Muhsam, <sup>66</sup>Citron, <sup>67</sup>Wassermann and <sup>68</sup>Bruck, and <sup>69</sup>Cohn, employing tuberculin as the antigen, obtained a positive result in a varying percentage of cases, but the value of the test was nullified by the fact that all syphilitics and many healthy individuals also gave a positive result.

In 1913 <sup>68</sup>Besredka used a broth from which the tubercle bacilli had been filtered and, in conjunction with <sup>69</sup>Manoukhine, he tested 750 suspected syphilitics of whom 9.2% gave a positive, 2.1% a partially positive and 88.7% a negative result. Of the 69 positive and of the 665 negative 74% and 38% respectively had a positive Wassermann. In testing a further 150 cases they found that 43 non-tubercular were all negative, while 107 tubercular cases were all positive with a few exceptions in moribund cases. <sup>70</sup>Inman with Besredka's antigen found 24 positive in 100 non-tubercular hospital cases. He further showed that all those/

those with a positive Wassermann gave a positive tuberculous reaction. In definite tuberculous cases 95% were positive and with a 32 fold dilution of the serum 48% still gave a positive result while the non-tubercular cases were now all negative. He considers that a repeated positive result at a 32 fold dilution is indicative of active disease, in the absence of a positive Wassermann.

71

Dudgeon, Meek and Muire tested many antigens but found dead tubercle bacilli the most satisfactory. They considered that the intensity of the reaction did not depend in any way on the severity or chronicity of the disease. Cases receiving tuberculin all reacted strongly. Their results are tabulated below.

72

Radcliffe, McIntosh and Fildes used living tubercle bacilli while Craig made use of different strains of organisms as a polyvalent antigen. I tabulate their results.

73

Observers.	Active Tuberculosis		Quiescent Tuberculosis		Non-Tubercular		Syphilitis	
	A.	B.	A.	B.	A.	B.	A.	B.
Radcliffe	467	86.5%			52	0		
McIntosh and Fildes	85	70.6%			87	2.2%	18	0%
Dudgeon Meek and Muire	102	84%	19	74%	9	0		
Craig	107	96.2%	39	66.1%	*250	2.3%	150	0%

A. = Number of cases tested.

B. = % +

\* 150 of these were syphilitic.

The above figures show a considerable improvement on the figures obtained with the Besredka antigen especially as regards the reaction of syphilitics.

The most recent investigations on this subject have been conducted by Wang and Crocket.<sup>51</sup> They used the bodies of tubercle bacilli, from which the fatty substances had been removed, as antigen. They further devised a method of annulling the reacting substance in a Wassermann serum without affecting the tubercular anti-body, thus allowing of discrimination between the two reactions. In 85% of 104 active tuberculous cases they found that fixation of complement occurred while in 220 non-tubercular cases there was no fixation. Of the 220 non-tubercular cases 200 had positive Wassermans. These results would seem to indicate that a positive result is diagnostic of active tuberculosis while a negative result, although not absolute, is very significant.

The above investigation appears to have placed this test on a sound basis and it has, should future work confirm the results, provided a valuable means recognising the early stages of active disease.

THE TUBERCULO-OPSONIC INDEX IN DIAGNOSIS.

53

In 1903 Wright and Douglas discovered substances in the blood which acted on bacteria and rendered them more vulnerable to the phagocytic action of the polymorph leucocytes. To these substances they gave the name Opsonins. It was further established that opsonins were specific for various organisms.

Wright elaborated the technique of a biological test whereby the amount of opsonin in a serum can be expressed in terms of the normal; this is the opsonic index. Thus, if the opsonic index of a serum is 0.5, it means that that particular serum contains half the normal quantity of opsonin.

74

In 1906 Wright showed that the tuberculo-opsonic index in healthy individuals varied within certain definite limits - namely 0.8 and 1.2. Hollister has confirmed this result. I tabulate his results.

75

No. of Case	No. of Examinations.	Average of any three consecutive readings.
1	71	varied between 0.9 & 1.1
2	95	" " 0.9 & 1.1 (except one which was 0.8)
3	82	" " 0.9 & 1.1
4	51	" " 0.9 & 1.1
5	50	" " 0.9 & 1.1

In/

In the above 349 readings the average opsonic index was 1. In a further examination of the blood of 100 individuals the opsonic index was between 0.8 and 1.2 with six exceptions. In two of the exceptions there was a family history of tuberculosis and clinical "suspicions" of lowered vitality. These results accord with the findings of Bulloch,<sup>76</sup> while Wolff and Reiter<sup>77</sup> have further narrowed the normal limits to 0.85 and 1.15.

In a tuberculous individual the opsonic index fluctuates so that it is rare to find it within the normal limits at two or more examinations or, again, the index may remain above or below the normal range. Further, in tuberculous subjects, following an injection of tuberculin, the index behaves in a characteristic fashion. After a slight temporary rise it falls (negative phase) to rise again (positive phase) to a level higher than the original index. It has been shown that in healthy individuals there is no negative phase. (Da Costa,<sup>78</sup> Lawson and Stewart,<sup>79</sup> Fraser,<sup>80</sup>).

The variations in the tuberculo-opsonic index, in a tuberculous case, were explained by Wright on the theory of Spontaneous Auto-inoculation of toxic products from a tuberculous focus, and so led to the application of auto-inoculation to the diagnosis of tuberculosis. Freeman<sup>81</sup> showed that massage of a tuberculous joint produced auto-inoculation and the same/

same was shown to be true of exercise, hyperaemia,  
<sup>82</sup>  
 and operations on a tuberculous focus.

The method of carrying out the test is to examine the opsonic index before auto-inoculation and at vary-  
<sup>83</sup>  
 ing intervals after it. Crowe made the examination before and after exercise, then six hours later and again the following morning. The method of producing the auto-inoculation must vary with the site of the disease but exercise, if not contra-indicated, is the usual method adopted. Considerable experience and judgment are required to gauge the requisite amount  
<sup>83</sup>  
 of exercise without overdoing it. Crowe quotes a case in which harm was done by evoking too great a response.

The opsonic index must be examined with a view to answering three questions.

1. Is it constantly within the normal range?
2. Does it fluctuate outside the normal range?
3. Is it persistently low or persistently high?

Observers agree that in active tuberculosis the index is not constantly within the normal limits. Wolff  
<sup>77</sup>  
 and Reiter found that in 12% of cases it was normal at one examination but never at two or more examinations.  
<sup>52</sup>  
 Inman considers one examination valueless as in 200 tuberculous cases he found it between 0.8 and 1.2 in  
<sup>83</sup>  
 101 cases. Crowe concluded from his results that the opsonic/

opsonic index was of great value in the diagnosis of tuberculosis in its earliest stages and further that it is an indication of the point when treatment may be stopped or should be started. Inman agrees with Crowe that in arrested cases the index may remain within the normal limits after the most arduous exercise.

Various conclusions have been suggested by a high or low index. Wolff and Reiter believe that chronic or stationary cases show a moderately low index, 0.7 as an average. While a very fluctuating index would suggest progressive disease. Inman groups his cases in four categories.

- A. Low index rising after exercise.
- B. Low " failing to rise after exercise.
- C. High " falling " "
- D. High " failing to fall " "

A. and B. appear to indicate chronic or localised cases while C. and D. are suggestive of greater activity.

Kossler and Newmann found a low index in afebrile and a high index febrile cases. Colebrook expresses a warning of caution against the interpretation of low indices, having found them in non-tubercular cases suffering from Diabetes, Syphilis, and Chronic Staphylococcal infections.

In considering the application of the test to diagnosis/

Figure N

UPSONIC INDEX OF A CASE RECORDED BY WRIGHT

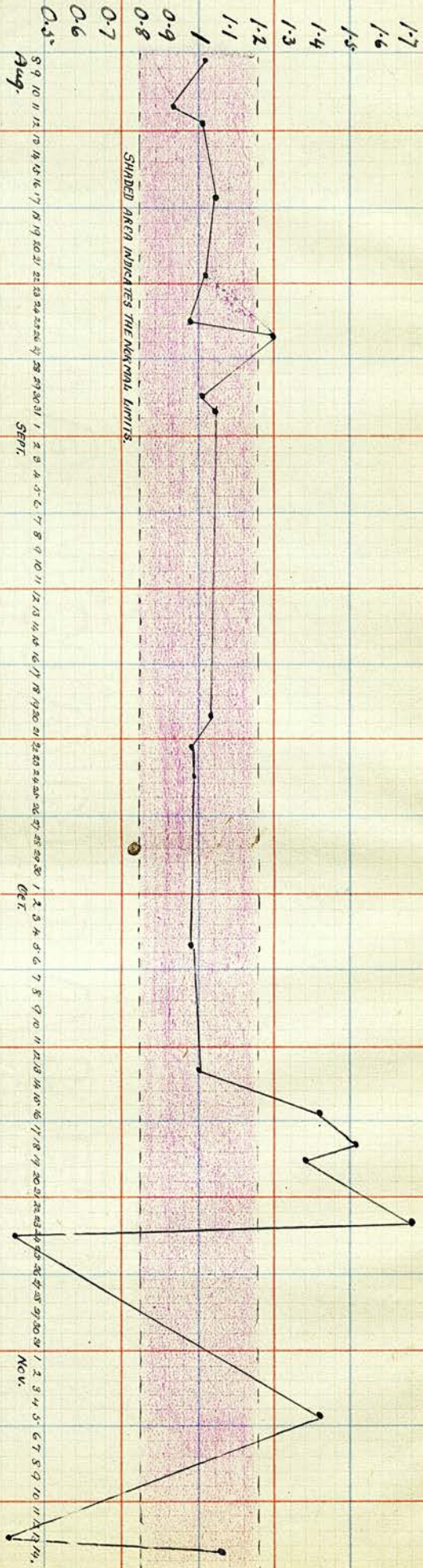
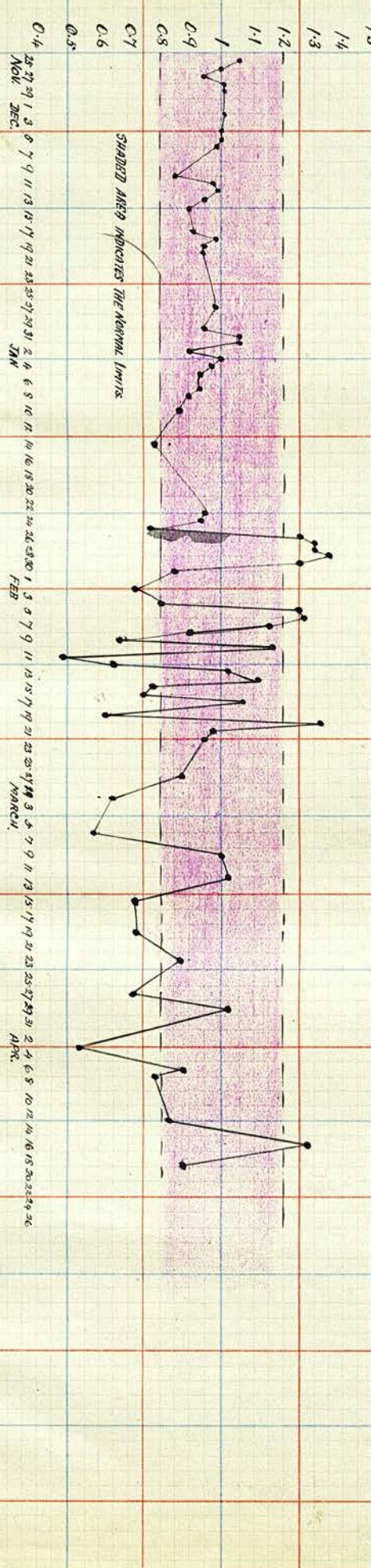


Figure V

UPSONIC INDEX OF A CASE RECORDED BY WRIGHT



diagnosis in the early stages of activity, I instance  
 83  
 two cases recorded by Wright and his collaborators.

Case 4. The case of a worker engaged in Wright's laboratory whose serum was used as a control. His opsonic index never varied outside 0.9 and 1.1 during ten weeks, except on one occasion when it was 1.25. It commenced suddenly to fluctuate without other indications of the disease and later an acute febrile attack with loss of flesh supervened. This was diagnosed "Influenza". He made a rapid recovery and regained his weight but, as his opsonic index continued to fluctuate, he gave up laboratory work and took outdoor employment. Later a tuberculous epididimitis made its appearance. Figure 4 shows the variations in the opsonic index.

Case 5. That of another worker engaged in Wright's laboratory whose serum was used as a control. Between November 25 and January 14 his opsonic index varied between 0.8 and 1.1. Towards the end of January it commenced to fluctuate and a swollen gland appeared in the submaxillary region, which, however, subsided. The chest was examined but no definite diagnosis could be made. The index continued to fluctuate and three months later tubercle bacilli appeared in his sputum. Figure 5 shows the variations in the opsonic index.

The/

The results obtained by an examination of the opsonic index suggest that it would be of value in the discrimination between active and inactive tuberculosis. I believe it to be capable of this application but to be of universal utility it must be easily carried out and here the test fails.

81

Wright claims that an error of 5% is not exceeded in his laboratory but other observers have found a constant error of 10% and an error of 20% in every ten determinations with, exceptionally, an error of 100%. From personal experience of the test at Nordrach-on-Dee I can testify to the difficulties which beset the path of accuracy. These difficulties seriously mitigate against the wider application of the test, which, in the hands of experienced workers with adequate laboratory facilities, is, I believe, a valuable means of detecting early active tuberculosis.

I now wish to consider briefly what assistance may be obtained from the history of the patient in leading up to a diagnosis of tuberculosis. There are three lines along which this enquiry must be made, namely as regards,

- (1) Hereditary Vulnerability.
- (2) Acquired Vulnerability.
- (3) Exposure to infection.

#### 1. HEREDITARY VULNERABILITY.

It is known that tuberculosis tends to run in certain families and a history of tuberculosis in the parents should be carefully sought for. The effect of tuberculous parents on the offspring may be in one of two directions or both; first, there may be transmission of the tubercle bacilli to the foetus in utero; secondly, there may be an inheritance of a specific vulnerability which renders the offspring an easy prey to subsequent infection.

In regard to the transmission of the organism to the foetus in utero, the modern view is that, although such cases of transmission do occur, they are so infrequent as to be negligible. That it does occur is undoubted; MacFayden and MacConkey produced tuberculosis in guinea pigs by injecting the mesenteric glands/

89

glands of a still born child and Gaffky had a similar experience in the case of a child a day old. The possibility of a prenatal infection remaining dormant during foetal life and developing after birth has been suggested by experiments on eggs. When eggs in the process of incubation were inoculated with tubercle bacilli, the disease made no progress until the eggs were hatched. (Gartner, Weber and Befinger, Koch and Rabinowitsch). It has also been shown that in cows, while the virgin uterus is not susceptible, the pregnant uterus is comparatively frequently affected. Such facts are suggestive of a greater probability of hereditary transmission than is at present recognised.

In speaking of the inheritance of a specific vulnerability our present knowledge, or more correctly lack of knowledge, forbids anything but a hypothetical discussion on the nature of this inheritance. Clinicians have long recognised that an inherited vulnerability does occur. Holt says "Inherited predisposition is exceedingly common and really signifies a diminished resistance of the cells of the body to tuberculous infection." Karl Pearson arrives at the same conclusion from a statistical study. He shows that the parent is twice as dangerous to the offspring as the wife is to the husband and that the tuberculous mother is only slightly more dangerous than a tuberculous/

tuberculous father to children under 14 years of age. From this he argues that were infection the only factor husband and wife would be as likely to infect one another as the parent to affect the child; further that the tuberculous mother being in closer contact with the children would be much the more dangerous whereas the difference is only slight. It must be agreed that this specific vulnerability does exist and allowance must be made for it in building up a diagnosis. As an example the following case recorded <sup>96</sup> by Whitla is interesting. One member after another of a large family was forced to seek his livelihood abroad in diverse climates, "twelve members succumbed in this manner (Phthisis), though several of them had left home before their successors were born, and some lived to the age of forty."

There are other aspects to the question of inherited vulnerability which cannot be considered specific. Any disease in the parents such as syphilis or alcoholism reacts on the children rendering them less resistant to the inroads of disease. The same may be said of certain congenital structural defects. Clinical experience defines two types, the habitus phthisicus of Hippocrates, the long flat chest, protruding scapulae, delicate features, fine skin, long eyelashes and silky hair; or the coarse, pale and/

and sallow facies of the thick skinned and stunted scrofulous type. Here it is difficult to discriminate between cause and effect but the pictures are useful in drawing attention to a possible case of tuberculosis.

<sup>97</sup>  
 Davies believes that intermarriage among close relations is responsible for an inherited susceptibility and the work of Reffil <sup>98</sup> and Lendet <sup>99</sup> would appear to support this theory.

To many and diverse structural defects has been attributed a predisposition to the disease but little or no value can be placed on them in diagnosing tuberculosis.

## II. ACQUIRED VULNERABILITY.

Under this heading must be placed any condition which tends to lessen the vitality and lower the resistance of the child. Certain factors are recognised as being more potent than others, such as overcrowding, lack of fresh air and sunlight, catarrhal infections of the nasopharynx etc. Careful enquiry must be made into the personal history and surroundings of the child and the result placed to the credit or debit in the balance sheet of evidence for tuberculosis. The significance of these factors will be more fully dealt with in considering prophylaxis.

III./

### III. EXPOSURE TO INFECTION.

The possibility of tuberculosis developing will depend to a considerable extent on the opportunities of infection. The immediate sources of the tubercle bacillus are known and careful enquiry should be made into the possibility and extent of exposure to such sources.

In this connection, the health of those with whom the child lives demands attention. A history of open tuberculosis in parent or nurse must increase the liability to infection, especially if adverse housing and hygienic facilities exist. A history of bronchitis or "chest trouble" should not be accepted as such but should, if possible, be followed up by an examination of the person concerned and even a negative history may call for confirmation. <sup>100</sup> Reich quotes an example in the case of a town of 1300 inhabitants where two midwives divided the obstetric practice. One was tubercular, the other was not. Both employed the method of mouth to mouth blowing to establish respiration in the newborn. In 14 months ten infants delivered by the tuberculous midwife died of tuberculous meningitis while no case was recorded in the practice of the other midwife. Another example <sup>94</sup> recorded by Holt was the case of two young girls who were in the habit of playing round the bed of a tuberculous/

tuberculous patient. Within three months of that time both had died of tuberculous meningitis.

Help in diagnosis may also be obtained from an enquiry into exposure to bovine infection. Mothers will often state quite positively, in the case of bottle fed children, that all the milk has been boiled, but cross-examination will show that it was "sometimes" boiled, and that only as long as the child was bottle fed.

As showing the frequency with which a definite history of exposure can be obtained in tuberculous cases I record my finding in records of 88 consecutive cases of tuberculosis admitted to one ward of the Royal Hospital for Sick Children, Edinburgh.

Type of Disease.	No. of Cases	Exposure to Human alone	Bovine alone	Both.
Abdominal Tuberculosis.	21	3	7	2
Tuberculous Meningitis	20	0	7	5
Pulmonary Tuberculosis	35	6	9	9
Tuberculous Bronchial glands	5	1	2	0
Generalised Tuberculosis	6	3	0	0
Tuberculous cervical Glands	1	0	1	0
	88	13	26	16

This table shows that no fewer than 55 or 62.5% gave a/

a definite history of probable exposure to tuberculosis. Compare this with the table below and the importance of an inquiry into this factor in diagnosis and the necessity of dealing with it in prophylaxis. will be recognised.

Children admitted to R.H.S.C. for diseases other than Tuberculosis.

No. of Cases	Exposure to		Both
	Human alone	Bovine alone	
50	6	15	2
		46%	

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PREVENTION.

Post mortem findings, in conjunction with the tuberculin tests, have resulted in the differentiation of two groups of cases, latent and active tuberculosis. The latent group includes those who harbour a tuberculous focus without showing signs or symptoms of the disease, while in the active group are placed those showing clinical evidence of disease. Such a division is natural and valuable but its limitations must not be over looked.

The small inactive force of tubercle bacilli, isolated and hemmed in by the resistance of the child, held up at the first line of defence, the lymphatic glands, may, at any time, find the forces against it weakened and an opportunity offered for an invasion which may only terminate with the death of the child. How often, for example, when enquiring into the onset of a case of tuberculosis, it is stated that the child has never been the same since it had measles. Is the explanation of this that an infection, following measles, gained the upper hand or is it that a prior infection has become active? I am strongly of the latter opinion. Dr John Simpson of the Royal Hospital for Sick Children kindly permitted me to look/

look through some of the records of cases of tuberculosis in his wards and in one series of nineteen cases of abdominal tuberculosis I found that in five cases the date of onset of symptoms correspond to an attack of one of these diseases. MacManus<sup>1</sup> remarks that "a swollen condition of the mediastinal group of glands is marked in some cases of whooping cough and measles, and this condition is eminently favourable to the growth of tubercle in them"; this might be put more definitely by saying that those cases of measles and whooping cough which show latent tuberculous enlargement of the mediastinal group of glands are prone to the development of active tuberculosis.

I lay emphasis on the importance of latent lesions as they call for treatment to prevent dissemination of the disease. Tuberculosis limited to lymphatic glands is more amenable to treatment than tuberculosis which has spread to other organs and just as a Surgeon would not, willingly, stay his hand to watch a case of septic lymphadenitis becoming a septicaemia or a pyaemia, before attempting, by active interference, to cure the disease, so should valuable time not be lost in dealing with tuberculosis.

The prevention of tuberculosis in childhood involves, firstly, a consideration of the sources of infection/

infection and their control.

#### HUMAN INFECTION.

It is now recognised that the main vehicle of human infection is the Sputum of phthisical patients, together with the droplets of secretion which are emitted in the act of coughing. The bacilli may also be found in the excreta but the opportunities offered to this source of infection must be few and the part it plays a subsidiary one.

The Sputum of phthisical patients dries, is disintegrated and the tubercle bacilli mix with the dust of the atmosphere. The droplets of secretion expelled in coughing may share a similar fate or may directly contaminate food and thus convey infection to the child. Infection may also be transmitted by contagion as in kissing and phthisical patients must be educated to understand and guard against the risks to which they expose others by mouth to mouth kissing. The child by its habits and helplessness is particularly exposed to infection from phthisical patients. The necessity for nursing brings it into intimate contact with the adult while its mode of progression and size entails a dangerous proximity to dusty floors.

Any measures or organisation which is designed to control/

control human infection must have the following aims.

1. The early detection of fresh cases. Were this always possible it would operate in two ways; firstly, by enabling the patient to be placed under treatment at a time when the expectations of cure are high and, secondly, by pointing out the dangers to which he may expose others, to educate him so that in his mode of life he will avoid disseminating the disease. If the surroundings of the patient are such that adequate measures of separation and disinfection cannot be carried out in his home, it may be necessary to insist on his removal to some institution for as long as he remains in an infectious condition.

## II. Isolation of highly infectious cases.

It is most desirable that those in advanced stages of pulmonary disease should not be permitted to remain a source of infection for others; especially amongst the poorer classes where the necessary attention cannot be given to cleanliness, and lack of accommodation prevents separation from the rest of the household. This may be difficult to accomplish without offending the susceptibilities of the patients and their friends and so leading to the concealment of future cases but it should be facilitated if discrimination and tact are supported by arrangements which/

which will make the visits of friends easy.

### III. The prevention of expectoration.

Needless to say every phthisical patient should be provided with, and instructed in the use of, a Sputum flask, but measures must also be designed to restrain promiscuous expectoration by the public in general which has become such a lamentably common habit among a large section of the population.

<sup>2</sup>  
 Hillier, at the International Conference on Tuberculosis in 1904, proposed that the police should, in all countries, cooperate in putting a stop to the practice of spitting in public but it was decided to limit the interference to closed places on account of opposition from German and Austrian delegates. This attitude is incomprehensible. A man urinating in public is liable to prosecution, although he is not in this way disseminating disease, while the man who expectorates, liberating perhaps millions of tubercle bacilli, is unrestrained.

In this "enlightened" age we recall with horror the insanitary conditions which must have existed when the cry "Gardyloo" was heard in our streets and it may well be for future generations to stand aghast when reminded of the injunction which at present adorns our lamposts.

IV./

#### IV. Disinfection of contaminated houses.

When a fresh case is notified every endeavour must be made to free the surroundings in which he has lived from possible infection. This measure is at present undertaken by the Medical Officer of Health and should yield satisfactory results. That it may be used to the greatest possible advantage entails its repetition at various times.

(a) On notification the bedroom, living room, and bedding of the patient should receive attention.

(b) Again on the removal of the patient to another house or to an institution.

(c) And on the death of the patient.

(d) And at frequent intervals when the patient is treated in his home.

To carry out the disinfection one of two methods may be adopted, the gaseous, or the wet method.

<sup>3</sup>  
Delepine tested the gaseous method as regards tubercle bacilli with sulphur and euchlorine. Both proved ineffective. The first was non-efficient in 66% of cases and the second in 84%. On the other hand formaldehyde has been largely used and has proved most efficient. The wet method is more convenient and easily applied. A fine spray of formaldehyde is used which has the advantage over most wet methods of not/

not damaging clothing. It has been found eminently  
<sup>4</sup>  
 suitable.

### BOVINE INFECTION.

The part played by this infection in childhood is of the greatest importance. The Royal Commission on Tuberculosis, 1911, found that 50% of primary abdominal tuberculosis in childhood was due to the bovine type of bacillus and the view now held is that milk and milk products are the main vehicles of transmission.  
<sup>5</sup>

The problem of the prevention of this type of infection must entail a consideration of the following.

1. The prevalence and eradication of bovine tuberculosis.
2. The delivery to the consumer of tubercle free milk.
3. The sterilisation of milk.

The table below shows the frequency with which milk delivered in some of our largest cities is infected.

TABLE./

## (6) Percentages of Samples showing presence of Tubercle bacilli.

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910.
Manchester	8.7	8.57	10.42	6.7	6.15	6.2	5.74	8.28	5.14	
Liverpool County Samples	6.1	7.3	5.1	9.2	3.8	6.8	4.7	3.3	1.8	4.1
Sheffield County Samples		17.8	16.7	6.7	14.7	9.6	9.7	9.9	10.9	10.4
Birmingham County Samples		prior to 1908 = 14%						11.3	7.5	7.3
Leeds County Samples								25.3	16.4	
Sunderland							2.5	7.0	7.4	3.6
London (L.C.C.)								11.6	10.4	

It is noted that there has been some diminution in the frequency of contamination but the drop has been neither consistent nor marked. <sup>7</sup> Rosenau commenting on this table says, "It is evident that the English method of dealing with bovine tuberculosis is a failure." I agree.

Mitchell has pointed out the futility of the present system of inspection of byres and the supervision of the milk supply of towns in Scotland. In Edinburgh, for example, a tuberculous cow need not be slaughtered, but must be removed from a city byre within twenty four hours and there is nothing to prevent/

prevent the transference of the cow to another herd outside the boundaries of the town. The law only makes the sale of milk from tuberculous cows illegal when the udder is affected; this is in spite of the fact that "Tubercle bacilli may and do gain access to milk from cows which clinically show no signs of udder tuberculosis."<sup>6</sup>

The complete eradication of tuberculosis in cows is held to be a feasible proposition by most authorities.<sup>9</sup> Delepine considers that if the measures he suggests were adopted the work could be accomplished in ten years. His recommendations are as follows.

1. "Division of the whole country into a number of well defined administrative areas, each provided with an efficient staff of inspectors.

11. Marking and registration of all cattle for purposes of inspection and notification. Systematical periodical inspections of herds within each administrative area. Testing all cattle with Tuberculin.

111. Isolation of all tuberculous cattle. Disinfection of sheds which have been occupied by tuberculous cattle. Exclusion of insanitary stables.

IV. Immediate slaughter of all cattle in an advanced state of tuberculosis (including all cases of udder tuberculosis).

V./

V. Fattening of all animals not in an advanced state of tuberculosis for the meat market. All cattle should be slaughtered in public abattoirs, so as to insure thorough meat inspection.

VI. Compensation during one year or two for losses incurred by owners of cattle, except in cases regarding which there has been gross or culpable neglect. After this transitional period of compensation the presence of a case of advanced tuberculosis in a cowshed to render the owner liable to a penalty.

VII. Testing of all cattle brought into the area, so as to prevent the introduction of fresh sources of tuberculosis. No cattle above six years of age to be imported.

VIII. All the milk from tuberculous cattle to be boiled before being used for feeding animals.

IX. Control of all imported foreign dairy produce, so as to enforce the same standard of purity as in home produce.

X. To avoid a sudden national depression in the dairy industry, which would be favourable to foreign produce, I further suggest that the enforcement of these measures should not be simultaneously carried out all through the country, but that they be at first enforced in a certain number of administrative areas, to/

to which year after year other districts should be added, until the whole country was under administrative control."

The delivery to the consumer of a tubercle free milk presupposes the eradication of bovine tuberculosis but it also entails the assurance that the milk has not been contaminated in its journey from the cow to the consumer. To ensure this strict measures of cleanliness must be enforced in the care of the utensils in which the milk is carried and above all no person suffering from tuberculosis must be allowed to milk cows or handle the milk in transit.

The population have the right to demand that they be supplied with tubercle free milk.

The sterilisation of milk should, I think, play subsidiary part and should only be adopted until bovine tuberculosis has been stamped out.

At the present time efforts are made to impress upon mothers the importance of sterilising milk either by boiling or pasteurisation. A certain number are conscientious and carry out adequate sterilisation but the vast majority either do not understand or do not care to what risks they expose their children. Even among the better class the warnings given by Doctors are unheeded and the usual excuse reminds me of/  
of/

of the soldier's reason for refusing inoculation, namely, that he had a friend who had not been inoculated and who had not contracted typhoid fever.

Further the young mother finds her time so taken up with household duties that she can, in many cases, ill afford the few minutes a day necessary to carry out the sterilisation. Another point, frequently overlooked by those giving advice, is that sterilisation should not be adopted only in the case of bottle fed babies but for all older children as well; that they may be better able to resist infection is no excuse for neglect of any precaution. Calmette and Breton<sup>10</sup> urge that milk should always be boiled before being taken by adults and a fortiori by children.

My experience, limited as it is, has convinced me that no amount of preaching to mothers will ever adequately secure efficient sterilisation at home. Believing this to be correct, I urge the adoption, in all centres where it is practicable, of the wholesale sterilisation of milk before it reaches the consumer; this to be continued until tubercle free cows can be guaranteed.

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Glaister notes that pasteurisation is carried out on a large scale both in Copenhagen and Berlin.

I must add, however, that no degree of purity in the/

the milk supply will ever be an excuse for denying the infant that which nature provides. Much may be done to encourage the mother to suckle her children. Where possible factories must provide crèches so that the mother can suckle her child and still carry on her work. The support of all employers of female labour must be solicited to forward such a movement. In Italy and Portugal such establishments are obligatory in every factory employing female labour and it is hoped that Public Authorities in this country will realise their responsibility in enforcing a similar scheme.

#### PREDISPOSING FACTORS.

In approaching the problem of prevention from the point of view of the predisposing factors, it will be seen that they operate at two definite stages on the road to active disease. Firstly, in the absence of predisposing factors, even if exposed to infection, the child will be better qualified to resist or completely overcome the disease. Secondly, having failed to prevent infection and supposing latent disease to exist, the presence of predisposing factors will tend to encourage the lighting up of the latent process and the onset of active disease. The removal/

removal of the predisposing factors, as far as this is possible, must, then, be considered as not only of importance in the prevention of infection but essential in the active treatment of latent cases.

#### ANTENATAL.

Prior to the discovery by Koch of the tubercle bacillus, the view was held that tuberculosis was mainly a hereditary disease. When, however, the casual organism was demonstrated the pendulum swung in the opposite direction and the main emphasis was laid on infection. Within recent years the tendency has been to adopt the view that each factor plays its own definite part. In discussing hereditary vulnerability I pointed out that an inherited susceptibility must be acknowledged to exist and further that any grave disease in the mother must reduce the vitality of the child.

The question arises then, should or should not a tuberculous person marry. This is a difficult question to answer but I believe that, in the case of active disease, the answer must be quite definitely "No". With the development of a health conscience the question would probably solve itself. If the warnings of the risks a mother runs not only to herself but to her children are unheeded, then, I think it is the Doctor's duty to the State to urge that there be no children/

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children. Pearson in this connection says, "there is an antisocial disregard for national Eugenics in the conduct of medical men who can write to the press that marriage or even the inter-marriage of tuberculous stocks is no social detriment, provided they live with a good supply of fresh air."

The question of the care of the pregnant woman also demands the attention of the State. This will entail financial assistance to allow her to secure physical rest before and after parturition. She must be enabled to leave her work without financially embarrassing her family and to secure the care which her condition demands either in her own home or in suitable maternity hospitals. Only by such measures can the health of the infants be maintained and the crusade against tuberculosis advanced.

#### TOILET OF NASOPHARYNX.

Believing that in childhood the main portal of entry of the tubercle bacillus is the area comprising the nasopharynx, pharynx, buccal and nasal cavities, everything must be done to maintain the vitality of these parts. Enlarged and unhealthy tonsils and adenoids must receive attention. Apart from the deleterious affects which they exercise upon respiration, hearing and intelligence, the presence of such diseased/

diseased tissue must facilitate the invasion of micro-organisms. It is only necessary to recall the frequency with which the tonsillar gland is the first to show gross pathological change in tuberculous cervical lymphadenitis, to emphasise this point. In this connection Peters says, "It is clear that removal of adenoids and tonsils does check the formation of definite tubercle in the cervical glands; whether due to diminished invasion, improved health, or less septic absorption is uncertain" and Holt is of the opinion that children with enlarged tonsils contract tubercle more easily than others.

Further the teeth must be attended to with scrupulous care. Dental caries and oral sepsis are well recognised sources of auto-intoxication in the adult, but little emphasis has been laid upon the possibility of an invasion of tubercle bacilli by this route. Here is an opportunity offered for the instillation of practical hygiene into the young.

The toilet of the nasal cavity must also not be neglected. Renshaw has pointed out the close connection which exists between the nose on the one hand and the meninges, lungs and cervical glands on the other while Demme records a case of tuberculous meningitis following ulceration of the nose.

The glands which form the first line of defence of/

of these portals of entry must be protected from the irritation and septic absorption arising from such diseases as pediculosis capitis and impetigo. The early detection and treatment of such conditions would be facilitated if, as Marsh suggests, local practitioners visited the schools in their districts every morning to see such children as the teachers suspected were suffering from these ailments.

#### INFECTION DISEASES.

The infectious diseases from which children suffer must be considered as predisposing to tuberculosis. Measles and Whooping Cough are in the forefront of these diseases and, although statistics to bring out this point are lacking, there is a general consensus of opinion among clinicians that they undoubtedly favour the onset of tuberculosis. Tuberculosis is more usually a sequel than an actual complication of these diseases and as the interval which elapses between this complication and the convalescence from Measles varies, it is difficult to define correctly the role which such diseases play. It is probable that by lowering the vitality of the patient they allow a latent focus to take on active characters but there is also the possibility that the associated catarrh/

catarrh of the upper respiratory passages facilitates the invasion of the tubercle bacillus should exposure to infection occur.

To reduce the liability to such diseases, especially in ill nourished and debilitated children, must be the first consideration. This end would be, at least partially, attained by the treatment of such children in open air and forest schools. During and after the attack the condition of the mouth must receive attention and further, following the illness, the children might, in cases where the home environment is unsatisfactory, return to ordinary life by way of the forest schools.

#### SCHOOL LIFE.

In the present age of educational pressure, overstudy is a factor which must not be overlooked as tending to produce debility. It has long been known that overstudy lowers the tone of the nervous system and through it that of the whole body; development is checked and the child is rendered more liable to the disease. The detection of the onset of overstudy is not a matter which falls readily into the province of the doctor, but the teachers who are in intimate daily contact with the children must be on the outlook for, able/

able to recognise and to remedy this evil.

At school the child is exposed to another danger which is insufficiently recognised in this country, the tuberculous teacher. In Scotland, at various periods during and at the completion of training, teachers undergo a medical examination but thereafter the question of their health receives no attention. Although suffering from tuberculosis in a highly infective form they may continue to teach, and to infect, the children. Parents have a right to demand that those who teach shall not at the same time infect their children. No mention of this is made in the Departmental Committee's Report on Tuberculosis but it is recommended that "no infected child may be sent to school, and no child from an infected house can be sent or admitted to school, unless the medical officer or medical attendant certifies that "proper precautions" against the spread of infection have been taken and that the child can attend school without risk."

#### HOUSING.

In no disease is general hygiene more important. Careful consideration must be given to the influences which surround the child in its home and those which tend to depress vitality or increase the opportunities of/

of infection carefully eliminated.

In the overcrowded slums of our large towns the death-rate from all causes shows a marked increase as compared with the more thinly populated districts. This is exemplified in the table given below.

Death-rate per 1000 of the population  
for various districts in Glasgow.  
11(Glaister.)

District.	No. of persons per acre.	Death-rate per 1000.
Kelvinside	9	6.47
Hillhead	12	9.66
Blythswood	107	15.60
High Street (west side)	242	26.66
Cowcaddens	280	32.66

The mode of operation of overcrowding in raising the death-rate is easily understood. In an overcrowded room the air becomes rapidly foul, lowering the vitality of those living in it while at the same time the herding together of large numbers of the population increases the opportunities for infection. Furthermore in the areas where overcrowding exists the houses are generally least sanitary and least exposed to sunlight. Even amongst the better classes when conditions favour ventilation and sunlight it is notorious/

notorious how often the colour of a carpet and the fear of a draught drives otherwise intelligent people to exclude nature's antiseptics. The following table<sup>20</sup> illustrates the effect, not only on the general death-rate but on the incidence of pulmonary tuberculosis and infant mortality, of herding together families in one or two roomed houses.

TABLE./

Ward.	Number of 1 or 2 roomed houses	Death-rate per 1000	Pulmonary notifica- tions per 1000 of population	Infant Mortality.
Carlton	1901	13.5	3.7	93
Cannongate	2793	15.2	4.0	113
Newington	534	12.4	1.5	46
Morningside	144	10.9	1.4	29
Merchiston	734	11.1	1.4	58
Gorgie	1718	11.6	2.6	81
Haymarket	516	11.6	1.4	104
St Bernards	915	11.5	1.5	66
Broughton	1173	11.2	2.5	80
St Stephens	1150	13.9	2.2	78
St Andrews	1302	13.1	3.5	106
St Giles	3010	21.5	6.2	142
Dalry	3103	13.9	4.1	107
George Square	2093	14.9	4.4	135
St Leonards	3325	16.2	4.4	125
Portobello	1086	14.3	2.1	116
City		14.3	3.1	101

6 one apartment houses in St Giles to one in Dalry.

5 " " " " St Leonards to one in Dalry.

3 " " " " George Square " " " "

It cannot be doubted, then, that the housing of a great part of the population in one or two rooms in large tenements is provocative of disease. Sir Robert Philip draws attention to "the appalling frequency with which several members of the same household, in the contracted dwellings of the poor, are simultaneously affected by tuberculosis".

It is impossible to lay too much stress on the importance of providing suitable houses for the citizens of the country. In the reports of the Local Government Board it is laid down that houses for "tuberculous" persons should be planned to secure "thorough perflation of air" and a large amount of sunshine in the living rooms and bedrooms. It seems to me that the qualification "tuberculous" might well be omitted if the most comprehensive view of the subject is to be taken.

There are no doubt many obstacles in the way of providing suitable houses in the centres of large cities but much might be done on the plan outlined by Shively<sup>19</sup> for the construction of suitable tenements in New York. These are provided with outside stairs, open air balconies communicating by large windows with the bedrooms and living rooms, while the flat roofs are provided with shelters, seats etc. Such a plan allows/

allows of an admirable openair roof playground for the children infinitely preferable to the street.

It seems to me that many of our large cities are committing a grave error in permitting the erection of high tenements with inside stairs. Inside stairs undoubtedly lend themselves to insanitary conditions while in high tenements, as at present constructed, without balconies or roof gardens, the older children play on the streets and infants remain indoors as the mother has rarely time to take the child out for more than a few minutes a day.

That good may be expected from improvements in the direction of better houses, even in the centres of large cities, is shown by the results of reforms in London, where blocks of slums were pulled down and sanitary buildings erected in their place. Over 22,000 people were housed in such buildings and, although the weekly earnings of the head of each family only averaged 22/3, the death-rate was 10.4 as compared with 14.3 for the whole city.<sup>20.</sup>

In all endeavours for the future to secure hygienic homes there must be a striving after the ideal which is portrayed by Sir Robert Philip in his address to the 77th Annual meeting of the British Medical Association. He says "Conceive a city built to-day de novo/

de novo in accordance with physiological and hygienic law. The structure and arrangement of the houses would be a first consideration. The sunless, airless dwelling would be impossible. Every apartment would have the maximum of sunlight. Windows would be framed so as readily to fulfil their other function, namely, to let in air. From infancy the infant would be trained to regard the dual function of the windows as vital to his safety. The nursery would especially be bathed in air and sunlight. The school room would be an object lesson in hygiene. None would be sanctioned whose ventilation was not in large part associated with the open window. There would be no school without a large playground. In fine weather much of the work would be done outside. Open spaces would abound. Crowding in dwellings, offices, work rooms, factories, meeting places, would be criminal. The housing of cattle would be similarly regulated. In such a city soil for tubercle would not exist. Tubercle would be unknown. It need never appear".

#### FEEDING.

Another factor which is of the greatest importance in maintaining the vitality of the child is the question/

question of feeding. The child, in addition to the supply of energy required to maintain body temperature and provide for all the activities of life, has the added burden of growth. During the years when the adult frame is being built up it is essential that the child should receive a sufficiency of proper food.

The food must be adequate in quantity. Overfeeding is no doubt detrimental to the health of the child but underfeeding is many times more injurious and much more prevalent. Children are seldom of their own accord gourmands or epicures and in a healthy child requests for food are the promptings of nature. As Herbert Spencer says "When to 'Oliver asking for more' the mamma or governess says 'No', on what grounds does she proceed? She thinks he has had enough. But what are her grounds for so thinking? Has she some secret understanding of the boy's stomach, some clairvoyant power enabling her to discern the needs of his body? If not, how can she safely decide?"

Besides being adequate in amount the food must be of the proper character. Too often is an infant denied breast feeding to be raised on starchy proprietary foods to the detriment of its health. In large cities, at the present time, there is ample evidence to show how badly the children are fed.

To/

To take only one disease which is due to improper feeding, Thomson<sup>21</sup> found that over 50% of children under three years attending his out patient clinics in Edinburgh showed unmistakable signs of Rickets. The ill-health caused by this disease in children is stupendous nor can its effects be measured entirely in terms of rickets for it predisposes to many other ailments, not least tuberculosis.

The older children of the working classes are too frequently brought up on a diet of bread, jam and tea. This may be the result of ignorance but much oftener it is simply the incapacity or laziness of the mother which prevents her preparing proper meals.

The marvellous way tuberculous children respond to fresh air and good food leaves no doubt in my mind as to the important part which improper feeding plays in the onset of the disease.

To secure adequate and proper feeding for children is a matter of education to teach the people what is required and a matter for the health conscience to see that the teaching is put into practice. Children taught more of the simple laws of nature, trained in plain cooking and domestic economy, will repay the State by tending, when they themselves marry, to rear their children on healthy lines.

POVERTY.

The two factors, housing and feeding, are intimately bound up with the question of the financial position of the family. Reincke has shown, by an investigation of the conditions in Hamburg that the death-rate from pulmonary tuberculosis varies inversely as the income of the family.

Table indicating the death-rate from pulmonary Tuberculosis in Hamburg among several groups of income tax payers (inclusive of the dependents of such tax payers) (Reincke).

Death-rate per 1000 in each class.

Income in Marks	1896	'97	'98	'99	1900	'01	'02	'03	'04	'05
900-1200	61.4	81.6	35.6	71.6	78.2	55.4	56.3	56.8	38.8	33.6
1200-2000	48.8	48.2	70.9	50.2	61.6	38.7	44.8	44.2	41.5	50.6
2000-3500	36.9	37.3	37.7	42.7	29.7	21.5	29.2	29.4	29.4	29.4
3500-5000	34.9	28.4	22.5	12.9	15.7	24.5	24.0	32.5	26.9	13.2
5000-10000	12.8	22.3	14.8	20.7	20.7	5.7	17.9	12.5	12.0	7.7
10,000-25,000	20.3	12.3	11.4	11.2	30.7	9.8	7.9	20.0	19.7	9.5
25,000-50,000	38.0	10.0	27.5	17.5	17.5	7.5	15.3	-	7.3	7.1
Over 50,000	-	-	-	-	24.7	-	-	-	-	2.1

It will be seen that the table is not absolutely consistent but the small number of persons in the higher classes renders the figures for these classes less/

less accurate. The general result however is to show that tuberculosis is more prevalent amongst the poor.

This raises the question as to cause and effect and Nathan Raw found that 40% of certain cases he investigated were poor because they were tuberculous. There can be no doubt that a long incapacitating illness in the wage earner, such as tuberculosis, must bring poverty and destitution to a great many families so that a vicious circle is set up, for it is equally certain that poverty increases the liability to disease. The State must, and does to some extent, remedy this condition of affairs. The families of the tuberculous poor, living as they do in a predisposing environment, must receive ample financial support from the State to allow them to live under hygienic circumstances and to build up their resistance by an adequate supply of good food. Such an investment would be economically sound in assisting the curtailment of the spread of infection and maintaining the health of the citizens.

How to meet the difficulty of the poor being more prone to disease is a more involved problem. Poverty is the result of a social and economic complex depending on such questions as a minimum wage, insurance against unemployment, alcoholism etc. which are/

are outside medical jurisdiction but which, if the conquest of tuberculosis is to be successfully carried forward, must receive earnest consideration. Modern legislation is showing a tardy realisation of the importance of these problems and there is greater hope for the future. Hand in hand with legislative measures, however, must go education; an education which aims not only at knowledge but the arousing of a conscience to put it into practice.

#### OPEN AIR SCHOOLS.

For the detection of early disease in the adult reliance must be placed on the patient reporting at an early stage of the disease; in children, on the other hand, the medical inspection of schools has opened the way not only to the diagnosis and relegation to suitable institutions of early cases of active disease but to the recognition of children in the "pretubercular" stage. Such children as are "delicate", "ill-nourished" and exposed to unhygienic surroundings or in contact with tuberculous adults must receive attention in open air or forest schools. To provide adequately for the vast numbers of delicate and pre-disposed children such schools are an urgent necessity. It is true that in certain of the larger towns in this country/

country open air schools exist but in a campaign against such a wide spread evil as tuberculosis the preventive measures must be equally comprehensive.

The aim of "open air schools" must be to provide for children who are "delicate" and "ill-nourished" the largest amount of fresh air and good feeding together with education. The schools would be situated in or around large centres of the population and the children would return to their homes at night.

In the centre of large towns there may be difficulty in providing such a school but if efforts were made to utilise roofs and roof gardens much might be done for a small outlay. The present school buildings might be adapted to provide a roof garden with open air class rooms, shelters and dining rooms; the last being not the least in importance. I am unable to find any example where roof gardens have been made use of for instruction in this country.

While the principle of "open air" schools is laid down for the "delicate" child it must not be forgotten that the ideal to be arrived at is that every school in the country should be conducted on open-air lines.

In the "open-air" school the time-table must vary according to the health of the children and should be drawn up by the Education Department under medical supervision but in every case it must include instruction/

instruction in the laws of health. In Pittsburg such teaching is carried out by specially qualified instructors and each pupil is given an illustrated pamphlet covering the grounds of hygienic laws, especially those relating to tuberculosis. As showing how forcible a factor this education, applied to children, may be, I quote, "We feel that after two years of this work nearly all the possibilities opened in Pittsburg to arouse an interest in tuberculosis have been more or less traceable to this school work. We place it far ahead of the other lectures given to adults and audiences specially gathered."

The folly of endeavouring in this way to care for a delicate child, who, although placed under the best conditions during the day, returns at night to a dirty, overcrowded, airless slum, must be apparent, and for such cases institutions are required in which the whole life of the child will be under supervision. Examples of such schools are to be found in the "forest" and "marine" schools of France and Germany. To these schools would also be sent convalescents from cases of active tuberculosis and "delicate" convalescents from measles and whooping cough so that there would be of necessity active co-operation between the Tuberculosis Dispensary, the Education Authority and the Medical Officer/

Officer of Health under whose control would fall the immediate supervision of the school.

### EDUCATION.

In the matter of education every effort would be made at "open air" schools to turn the children's attention to open-air pursuits so that on leaving school they would tend to select such occupations as would most readily lead, in after life, to a continuation of the regime of the school. Much might be done in this way by setting apart definite periods for the teaching of horticulture, the care of live stock, forestry and kindred subjects, while a certain number could be trained to take up domestic service in similar institutions. In this way the less robust children would be guided into occupations away from the depressing influences of thickly populated centres and, in hygienic surroundings, they would grow to be healthy useful citizens.

"Les Enfants sont ce qu'ou les fait" is an old French saying which is too often forgotten. The safeguarding of the health of the children is a responsibility which the community must face with greater realisation of its duty, not only to the individual but to the State and, if this is undertaken wholeheartedly/

wholeheartedly, the improved health of future generations will be adequate repayment while tuberculosis will be effectively controlled.

Gathered together under the Education Department, the children of the country present a well organised force, within the reach of educational influences at the most receptive period of life, and under efficient administrative control. "The child is Father of the man" and, if good use can be made of the excellent opportunities which are presented, the children can be taught the value of health and the main lines along which it can be maintained so that the development of a health conscience would be assured. Legislation may do much. It may provide tubercle free milk and sanitary houses but it cannot compel that scrupulous cleanliness, that love of fresh air, that respect for all that gives health, and disrespect for all that is detrimental to it, factors which are so essential if efforts are to be crowned with success. These aims must be approached from another standpoint, namely, education.

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