O B S E R V A T I O N S

ON THE CONTACTS OF

PULMONARY TUBERCULOSIS.

BY

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In the Final Report of the Departmental Committee on Tuberculosis (1) it is urged that "no effort should be spared whether by way of research with a view to discovering new methods of diagnosis or by the encouragement of the systematic and intelligent use of existing methods, especially in connection with the observation and examination of contacts, to ensure that the existence of the disease should be discovered in its earliest stages".

It is further stated that "one of the principal sources of danger at the present time is the existence of a number of persons in the more acute and advanced stage of the disease living in the intimate contact with their families and neighbours, which is necessitated by the ordinary conditions of their lives".

Newman (2) in his evidence to the Committee, described the German dispensaries at which arrangements were made for a "march past" of a family for examination of all suspects and contacts.

In recent Reports of the Chief Medical Officer to the Ministry of Health (3) the examination and observation of contacts are described as important functions of the Tuberculosis Officer which should be more extensively practised.

Households in which tuberculous disease has manifested itself are included in the "systeme de depistage" advocated by Calmette (4).

Before embarking on a scheme of observation of contacts, however, it will be desirable to know (I) if tuberculous disease is more common among contacts than among the general population, and /

and (II) if there is any method of "ensuring that the disease will be recognised in its earliest stages". For these purposes it is proposed to consider:-

(1) The after-histories of the contacts of 210 cases of pulmonary tuberculosis,

(2) The selection of contacts for further observation by means of the Dreyer co-efficients of physical fitness.

1. THE AFTER-HISTORIES OF 1162 CONTACTS.

The first object of any system of observation will be to select those who are in greatest danger of contracting the disease as the number of contacts, in the literal sense of the term, is almost unlimited.

In this connection it is instructive to refer to one of the opinions (5) expressed at a time when the communicability of tuberculosis was seriously doubted - "if phthisis is a communicable disease, it is so only under circumstances of extremely close personal intimacy, such as persons sharing the same bed or the same room, or shut up together in numbers in close ill-ventilated apartments".

This view is expressed in the language of to-day as the "Influence of Dose". Cobbett (6) states that very large doses are deadly, and overcome the most resistant, while very small doses are harmless even to the most susceptible. Calmette (4) believes that massive infections are the grave danger to those who have not yet been infected and repeated super-infections to those who are the subjects of latent disease.

It will be justifiable and expedient to concentrate on Home Contacts/

Contacts who are readily identified as those most intimately associated with the phthisical patient: and while it is outwith the scope of this enquiry to deal with the relative parts played by infection and predisposition, it is worthy of note that "contacts" so defined, have not only an intimate association with the disease but also a close blood relationship with the source of infection.

It will be an obvious condition that the infecting person really suffers from tuberculosis, is infectious, and excretes tubercle bacilli. For these reasons, the after-histories of those of Home Contacts of sputum positive cases of pulmonary tuberculosis.

The Material and Procedure.

There were available the records of all cases of pulmonary tuberculosis notified since 1911 in four parishes of the County of Lanark. The number was reduced by the sputum positive qualification and by the exclusion of such cases as were known to have left the district. A further reduction ensued when the attempt was made to trace those remaining and finally there were left 210 cases, only selected by these considerations.

The record cards had been completed at the date of notification and showed the names and ages of all persons resident in the house at that time. There fell to be added those who had died or left the house prior to notification but after the onset of illness, and any who had been born or come to reside after notification, but before the date of death or the present date as the case might be. Reliance had to be placed on the memory and goodwill of the informant for these additions /

additions, but they formed a small proportion of the total. The date of onset of illness was recorded on the card, and could be checked by the records of hospital physicians, which were also available.

It was desired not only to collect information uniformly and exactly, but also to form an impression of how such enquiries were received. A personal visit was made in each case, and the most responsible relative was interviewed. The reference by name to each member of the household was frequently a matter of surprise to the informant, and ensured an accurate account of the contacts at the date of notification, and the credit of being able to do so elicited ready information to complete the list. There was noted a history of the health of each contact and in the event of death such particulars as would enable the name to be traced in the returns of the local registrars. It was hoped to derive from this information an estimate of the morbidity and mortality among contacts.

Factors influencing the morbidity and mortality.

Without attempting to detail the numerous and complex influences affecting individual households, it is desirable to record certain features of the district, of the conditions of the people, and of the 210 cases dealt with.

The principal industries are coal mining and steel manu-:facturing, and the economic and social conditions of the people are those of these classes of workers. They experienced the variations in good fortune which preceded, accompanied and succeeded the Great War/

War, and the sickness and mortality which arose out of the pandemic of Influenza.

The general sanitary conditions are good, but in common with most urban districts, the villages have sacrificed the natural benefits of the country without acquiring the high standard of artificial sanitation of the large towns and cities. The special anti-tuberculosis campaign (7) has been waged with vigour and the organisation is of a high standard.

(I) Housing.

The housing conditions of the 210 cases at the date of notification are briefly summarised in the following table:-

No. of Apartments.	Cases.	Total Inmates.	Average number per house.
One	47	247	5.2
Two	126	844	6.7
Three	26	187	7.1
Four	11	79	7.2

It will be noted that 82% of the patients lived in one or two apartment houses which were actually, if not legally, over-:crowded. The kitchen is used by the sick person as his sitting room, dining room, and frequently his bedroom, and it is the common room of all the numerous inmates.

Given a consumptive with bacilliferous spit the opportunities for massive and frequent infection of the contacts were provided.

(II) Institutional Treatment and the Duration of Illness.

Opposed to the danger of these housing conditions was the influence /

influence of treatment in hospitals and sanatoria. Newsholme's well-known investigations (8) led him to the conclusion that institutional segregation is the most powerful single means available for controlling phthisis.

Of the 210 cases, 31 are still alive and are not considered as the duration of their illness is incomplete. The average duration of illness of the remaining 179 cases was 2 years 10 months, and of that period 15.6 months had elapsed before the patient came under supervision: the average period spent in hospital was 4.3 months, and during the remaining 14 months the spread of infection was limited by the effects of supervision and education. The duration of illness was probably a close approximation to the period of infectivity as the onset was dated to the appearance of symptoms and with few exceptions the cases were progressive with but short intermittences to their fatal termination. It would thus appear that one eighth of the period of infectivity was spent in hospital isolation, and by that much the chances of infection were diminished. It is no disparagement to the preventive teaching of the special institutions to place the practical value of education at a low mark when patients have to return to home conditions which must render their best endeavours - when they have them - ineffective in many instances.

Whatever their influence on the casual infections of the general populace may have been, it does not seem likely that institutional treatment and training vitally diminished the ample opportunities /

opportunities for infection of the home contacts in the cases under consideration.

(III) Age at Onset.

The average age at onset of the 210 cases was 27.1 years, and they were distributed in the following age groups:-

0-10	-15	-20	-25	-30	-35	-45	-55	& over.
4	22	57	22	29	24	34	12	6
4	22	79		53		34	12	6

The sputum positive qualification may have led to the exclusion of cases of chronic fibroid phthisis in the older age. periods, but it also excluded acute fulminating cases in the younger groups. The age distribution of these patients has a significance in the search for new cases among contacts and is of importance in assessing the results of any observations on contacts. It directs attention to the more likely victims, defines the period at which the danger is passing, and reveals the incompleteness of any series of family histories. It is of importance also in view of Brownlee's investigations (9) which suggested that different age types of phthisis predominate in different parts of the country, and that the "young adult" type of disease is disappearing more rapidly and probably losing its infectivity.

(IV) Present Age of the Surviving Contacts.

Of the total contacts, 1026 are still alive and their present ages are classified in these age groups:-

0-5	-15	-25	-35	-45	-55	& over.
33	256	321	149	82	90	95

Only 28% have reached the comparative safety which follows the age of 35; 46% are traversing the danger zone of 15 to 35; and 28% have yet to enter it. The casualty list as at the present must be incomplete, but on the other hand not a few are bearing the brunt of the battle.

Rusher and Kenchington (10) who investigated the mortality in a group of some 80,000, proposers for life assurance with a family history of tuberculosis, concluded that "the excess mortality is greatest in the youngest group of ages at entry, and that it is practically confined to the first 10 years of assurance. When each experience is compared with the normal mortality for the corresponding class of assurance, it will be seen that there is no trace of excess mortality in the endowment assurances above age 37 at entry, and in the whole life assurances after about age 50 at entry".

(V) The Relationship of the Cases to the Contacts.

Rusher and Kenchington (10) have "no hesitation in expressing the opinion that at least as much attention - if not more - must be given to a history of tuberculosis among brothers and sisters as amongst parents".

Pearson (11) found a greater incidence of phthisis among the offspring of tuberculous parents than among those in whom there was a history of fraternal infection.

In /

In the case of young children Calmette (4) finds the preponderating influence of maternal infection being constantly affirmed, and describes graphically the opportunities for infection of the young infant.

Of the 210 primary cases, i.e. those in whom the symptoms appeared first, the father of the family was affected in 50 instances the mother in 50, a brother or sister in 97, an uncle in 6, a grand-father in 2, a cousin in 2, and a grandchild, an aunt and a lodger in one instance each.

(VI) The period covered by the observations.

The most important factor is the duration of time covered by the observations. Tuberculosis has no definite incubation period and it is accepted that active disease may arise out of a latent lesion many years after infection. It is clear that the contacts of 1911 cases will have had greater opportunities in point of time of suffering, and dying from tuberculosis that those who came under observation in 1921. In this enquiry, which is concerned with the contacts alone of a known case of phthisis, no account has been taken of deaths which preceded the onset of illness and the observations may be regarded as having begun at that date which will be referred to as "the first date of exposure". In infants it was probably a first infection: to most adults it represented a super-infection. The date of notification is not a feature of the disease and is complicated by the varying periods of illness which preceded it.

The /

The number of years contributed from the first date of exposure to the present by 1162 contacts who came under observa-:tion on and after that date, amounted to 8930 years or an average of 7.7 years each.

THE MORBIDITY AMONG CONTACTS.

As an index to the prevalence of tuberculosis, notifications are of doubtful value, and are constantly being rejected by statisticians. On the one hand general practitioners may fail to notify cases, and Tuberculosis Officers are apparently liable to err on the other side. "The vagaries of the diagnoses of the Tuberculosis Officer are in complete accord with the vagaries of human crankdom". (Brownlee (9)).

The zeal of the specialist officer, however, can be checked by reference to hospital records and in addition to notifications there was available, information derived from the personal enquiries regarding each contact and from the records of home visits. From these sources, it may be possible to arrive at a fair approximation to the truth.

(I) Pulmonary Tuberculosis.

In the first instance, only cases which conform to the standard of diagnosis represented by the record of a positive spit or death from certified pulmonary tuberculosis will be considered.

Among 1162 contacts of 210 persons suffering from phthisis, there were subsequently discovered 49 cases of this type. In 39, the diagnosis was established by the record of a positive spit, and in 10 by death from certified pulmonary tuberculosis. /

Tuberculosis. Of the latter, 4 were not notified and 6 died shortly after notification.

The cases occurred in 40 families, there being 7 instances in which two persons in the same household were subsequently found to be affected, and one in which three were attacked.

The relationship of the subsequent to the first cases was as follows:- Father 6; mother 2; brother 10; sister 15; daughter 8; son 3; husband 1; step-sister 2; son-in-law 1; no relation 1.

In spite of the small number of contacts and the liability to error and false deduction, it is proposed to attempt a comparison by means of data which are known to apply to the general population.

There is unfortunately no information available to show the proportion of cases notified who have a positive spit, but it may be safely assumed that the number does not exceed 60% of the total notifications in Lanarkshire where special facilities for the treatment of early cases and children are provided and where consequently such notifications are numerous. For example, it is found (7) that the proportion of cases treated in hospitals, sanatoria, and work colony who have tubercle bacilli in the sputum is only 42%. If the average annual notification rate for the period 1911-20 is modified to meet the suggested proportion of 60%, the expected notifications among contacts at the rate obtaining for the whole district would have been 7.7 to the end of 1922. Actually 43 were notified /

notified as suffering from phthisis conforming to the diagnostic standard under consideration.

Notified cases of Pulmonary Tuberculosis, corrected to include only those with a positive spit, under observa-:tion on 1st January, 1923, amounted to 2.75 per 1000 of the general population. Contacts, notified and alive at that date, numbered 16.5 per 1000 contacts alive.

In these comparisons, it has been necessary to avoid the unmodified notification figure as this is probably unduly high in the case of contacts many of whom are notified, especially by the tuberculosis staff, largely on account of the family history. A similar objection might be made to the cases under consideration, but it should be noted that out of 34 deaths, 4 or 11.7% were not notified compared with an average of 16% for the whole district.

An excessive incidence of definite pulmonary tuberculosis among contacts may be held to have been established. Pearson (11) found that "we shall probably under-estimate the amount of the disease (Pulmonary Tuberculosis) if we suppose that, when family histories are completed, one-third of the off-:spring of all families having at least one tuberculous member will on the average be tuberculous". He also stated that judging by the death rates from pulmonary tuberculosis the number of the general population affected was certainly more then /

than 8% and probably less than 13%, and he took 10% as a round figure to work with. His minimum ratio for the incidence of pulmonary tuberculosis in tuberculous families was therefore over 3 to 1 of the general population.

R.E. Thompson (12) gives the data for 80 families with completed family histories in which at least one parent was affected. He found that phthisis was developed in 194 children out of 385 or a morbidity of rather more than 50%, and in addition, he noted, apparently with suspicion the deaths of 37 children who died young.

(II) Other tuberculous diseases and suspect illnesses.

When the diagnostic standard of a positive spit or death from certified pulmonary tuberculosis is deserted, the cases require careful scrutiny and the results are more open to suspicion and criticism. "The incidence of tuberculosis varies no doubt in different parts of the country ..... but the variations in diagnosis are unfortunately much greater than in incidence". (Newman (13)). This is inevitable in the case of a disease which frequently only admits of a "probably" or "possible" diagnosis. The lapse of time may dissipate doubt in some instances, but in many the period of waiting must prove beyond the possible observation of a single individual. /

individual. Moreover in cases where the disease has has aborted the diagnosis may come in time to be viewed with suspicion, even by the person who made the original examination and with more than suspicion by any subsequent observer.

Cases of non-fatal tuberculosis of all types occurr-:ing among contacts subsequent to the date of the first notification are now considered. Those who were notified and those who were discovered in the course of this enquiry will be dealt with separately and it will be understood that no systematic examination of all the contacts was made. The cases will be classified as definite, probable and possible, and an attempt made strictly to limit admission to the first two classes.

(a) Cases notified.

39 contacts other than those already dealt with were notified as suffering from tuberculosis which did not prove fatal, and of these, 9 were definite cases, 5 were probable and 25 possible.

The nature of the disease in the definite cases was as follows:- Multiple cervical adenitis - active 1; healed 1; Multiple glandular lesions with mass in hilus 1; arthritis 1; dactylitis 1; spinal caries 1; multiple bone lesions /

lesions 1; epididymitis 1; old pleurisy with effusion, healed cavity 1.

The probability or possibility of the remaining cases being tuberculous was estimated partly by their present condition, and partly by reference to records of previous examinations. Of the "probable" cases, 3 had suffered from cough following pleurisy, 1 from bronchitis and asthma, and 1 from chronic cough with severe anaemia and debility. All showed or had shown physical signs suggestive at least of invasion of the lung.

Of the "possible" cases, 19 were children of school age who had experienced a more or less definite illness with impairment of health for varying periods. They had complained of "bronchitis", loss of weight, anaemia, listlessness, anorexia, and kindred symptoms. The signs were variable and appeared to vary with the observer apart from any difference in the date of examination.

(b) Cases Discovered.

Of these, the diagnosis was definitely established in 10 instances as follows:- Healed cervical adenitis - single scar (1), - multiple scars (1); active cervical adenitis in a male aged 50, (1); glandular abscess in a female aged 45, (1); spinal caries (1); dactylitis (1); chronic /

chronic iritis with discrete interstitial corneal opacities (2); arrested pulmonary tuberculosis (2). In the case of the last named, a record of a positive spit seventeen years ago was found in one instance, and in the other, a written description of definite disease with repeated haemorrhages.

A brief description of 9 "probable" cases may be given thus:- chronic abscess of the chest wall (1), necrosis of the lower jaw (1); meningitis, recovery, paralysis, mental deficiency (1); phlyctenular conjunctivitis, cough, lassitude, loss of weight (1); repeated attacks of pleurisy, cough, debility (1); pleurisy and bronchitis (1); severe anaemia with emaciation in a girl of 17 (1); confinement, cough,debility, emaciation, pulmonary signs (1); chronic cough and invalidity, two wives died of definite pulmonary tuberculosis and the third wife has chronic laryngitis (1).

In addition there were 39 "possible" cases. Of these, 2 were babies under one year struggling to exist; 2 children of school age were small, puny, and would not thrive, and 1 had chronic enteritis; 5 children now of school age were delicate, difficult to rear, or wasted in babyhood, and their health was still impaired; 6 children of school age, 4 adolescents and 5 in early manhood had suggestive symptoms; 2 wives and 1 husband of phthisical spouses complained of cough /

cough, and general debility, and 1 wife looked ill and did not complain; 7 parents of tuberculous children had chronic bronchitis or asthmatical bronchitis, and 1 had chronic laryngitis.

(III) Remarks.

Of the definite cases, 16 were non-pulmonary in type and the nature of the disease as shown above is of interest. There was no example of abdominal tuberculosis and of six in whom the surface glands were affected, two had reached ages at which bovine infection is rare: three had multiple glandular disease, and only one showed the scar of a single tuberculous gland or mass of glands. The remaining ten were examples of haematogenous infections in situations where the human type of bacillus has been found to predominate.

Of children showing definite or suspicious evidence of tuberculous disease, 43 were under four years of age at the first date of exposure, and the fate of these infants was a feature of the enquiry. If they escaped death, they very frequently exhibited signs or symptoms of the process of tuberculisation. Some were complaining at the time of the visit: others bore the scars of an invasion successfully overcome for the moment at least. In the absence of /

of surface signs many of these illnesses in children are not subject to a diagnostic standard which would be generally accepted. The numerous signs and minutiae described as evidence of tuberculous disease exist and may be demonstrated, but the interpretation of their signifi-:cance is a matter of personal idiosyncracy. For example, a suggestive combination of symptoms and signs was neglected for the more definite evidence of a negative X-Ray examina-:tion and two years later the contact presented herself with a multiple glandular infection. Per contra, vague minutiae in the chest of a young female contact were pursued to the point of overlooking a uterine tumour, the removal of which resulted in cure.

Fishberg (14) found that the children of tuberculous parents at the age of 14, gave a positive tuberculin reaction in 83% of cases, and it will be safe to assume that a consider-:able proportion of these infections were not effected without provoking symptomatic evidence of their presence. The histor-:ies of children contacts certainly suggested that tuberculous anto-inoculation was common, and expressed itself in the form of illnesses not readily labelled.

In adolescence and early manhool, it would seem that the symptoms of recurrent tuberculous toxaemia which were commonly found in children did not manifest themselves and that the warnings /

warnings of impending disaster were not numerous. However, these are the ages at which the ostrich policy is most adopted and during which early symptoms are not revealed.

In late maturity and old age, suspicions illnesses and difficulties in diagnosis again present themselves. The asthma and bronchitis of the parents of tuberculous children has long been suspect. "I am convinced from observation of the nature of illnesses met with in tuberculous families ... that many cases of chronic phthisis have been wrongly spoken of as cases of bronchitis or asthmatical bronchitis". (Matthew Hay (15)). Again the compilation of an accurate morbidity rate is rendered almost impossible by the inherent difficulties in defining the disease and by the practical consideration that contacts at these ages will not readily submit to examination.

It is not surprising to find variations in the results of clinical examinations when divergence is revealed in the observations of those who have based their results on the more exact data of post mortem findings.

Of clinical investigations of contacts the following may be quoted. Ward (16) examined 1057 contacts other than husband and wife, and found 219 tuberculous, 284 suspect, and 564 negative, or roughly 20%, 27% and 53%.

Schram /

Schram (17) in an examination of 500 children between the ages 0 and 8, recruited from tuberculous homes, found that 79, or 15.8%, showed clinical signs of tuberculosis, and of 300 who gave a positive Von Pirquet reaction, 12, or 4%, had signs of enlargement of the bronchial glands.

Levinson (18) examined 300 children between the ages of 2 and 16, and of 141 who gave a positive tuber-:culin reaction, 75% showed signs strongly indicative of bronchial gland tuberculosis.

The figures which were stated above are summarised in the following table. They have little numerical value and are of interest rather in showing the type of case which falls to be dealt with. For the purpose of determining the relative incidence of tuberculosis among contacts the more reliable "definite" pulmonary tuberculosis figures and the death rates have been chosen.

	Definite.	Probable.	Possible.
Notified	9	5	25
Discovered	10	9	37

Affirming his belief in the infectivity of phthisis, Newsholme (8) confessed that "the evidence convincing one as to /

to this does not lend itself to statistical statement and when stated in print it may not be convincing ..... but it can leave no doubts in the minds of those who came into continuous contact with the actual facts".

Apart from any statistical evidence which is offered, a clear impression was formed that in addition to an increased prevalence of definite disease, minor manifestations of tuber-:culous infection were common among contacts.

TABLE I.

Age at first date of exposure.	Total.	Contacts Died.	Surviving.	Years survived by those alive. 1-3	3-5	-8	-10	-15	-20
Minus	100	41	59	*12	8	18	8	8	x5
0-2	77	13	64	7	9	16	10	18	4
-4	72	3	69	3	11	17	16	18	4
-6	66	3	63	6	10	17	14	13	3
-10	157	9	148	7	33	40	29	32	7
-15	185	15	170	11	31	54	28	41	5
-20	123	12	111	8	23	33	27	20	-
-25	70	4	66	5	11	22	14	14	-
-35	82	9	73	9	7	17	22	16	2
-45	97	5	92	6	20	21	19	19	7
& over	133	22	111	11	15	33	24	27	1
	1162	136	1026	85	178	288	211	226	38

* 4 have not yet completed one year.

x 3 have survived 20-25 years.

THE MORTALITY AMONG CONTACTS.

Table I classifies the contacts according to their ages at the "first date of exposure". The minus group comprises those who were not born at the date of the onset of illness of the infecting person. The total number of contacts in each age group is shown, and in addition, the number who died, the number alive at the present date, and the years which have elapsed since the survivors were "first exposed" to infection.

TABLE II.

Certified Cause of Death.	Total.	Age at first date of exposure.								
		Minus.	0-2	-4	-10	-15	-25	-35	-45	Over
Measles	2	1	1	-	-	-	-	-	-	-
Whooping Cough.	2	2	-	-	-	-	-	-	-	-
Influenza (including influenzal pneumonia)	5	2	1	-	1	1	-	-	-	-
Tuberculosis -										
Pulmonary	34	1	1	-	8	8	9	3	1	3
Meningeal	10	7	2	-	1	-	-	-	-	-
Abdominal	4	1	3	-	-	-	-	-	-	-
Spinal	1	-	1	-	-	-	-	-	-	-
Pneumonia (including broncho-pneumonia)	10	7	1	-	1	-	-	-	-	1
Bronchitis	4	2	-	-	-	-	-	-	-	2
Laryngitis	2	1	1	-	-	-	-	-	-	-
Empyema (unqualified)	1	1	-	-	-	-	-	-	-	-
Meningitis (unqualified)	6	3	1	1	-	-	1	-	-	-
" Septic	1	-	-	1	-	-	-	-	-	-
" Cerebro-Spinal	1	-	-	-	-	-	1	-	-	-
Atrophy, Debility & Marasmus	6	5	1	-	-	-	-	-	-	-
Enteritis (under 2 years)	6	6	-	-	-	-	-	-	-	-
Prematurity	2	2	-	-	-	-	-	-	-	-
*Other Defined	36	-	-	1	1	4	5	6	4	15
Unknown	3	-	-	-	-	2	-	-	-	1
	136	41	13	3	12	15	16	9	5	22

* These deaths comprise the following :- Cardiac 2; Pericarditis 2; Malignant Disease 3; Cerebral Haemorrhage 4; Nephritis 3; Perforated /

Perforated gastric ulcer 1; Appendicitis 1; Cholecystitis 1; Otitis media (cerebral abscess) 1; Parturition - and Peritonitis 1; and Bronchitis 1; Pneumonia 1; Violence 5; Killed in Action 4; Senility 5; Acute Rheumatism 1.

The certified causes of death extracted from the returns of the local registrars are detailed for each age group in Table II. The description of a fatal illness as given by relatives was found to be quite unreliable, and sometimes actually misleading, e.g., "an abscess in the chest" proved to be a perforated gastric ulcer, and "lumps in the stomach" a sarcoma of the kidney.

The ages at death as they occurred in each age group are shown in Table III.

TABLE III.

Age at first date of exposure.	Number of deaths.	Age at Death.								
		0-1	1-5	-15	-25	-35	-45	-55	-65	Over.
Minus	41	29	*11	1	-	-	-	-	-	-
0-2	13	3	x10	-	-	-	-	-	-	-
-4	3	-	2	1	-	-	-	-	-	-
-6	3	-	-	3	-	-	-	-	-	-
-10	9	-	-	4	5	-	-	-	-	-
-15	15	-	-	4	11	-	-	-	-	-
-20	12	-	-	-	11	1	-	-	-	-
-25	4	-	-	-	2	2	-	-	-	-
-35	9	-	-	-	-	5	4	-	-	-
-45	5	-	-	-	-	-	2	3	-	-
Over	22	-	-	-	-	-	-	6	6	10
	136	32	23	13	29	8	6	9	6	10

* 7 died under 2 years.

x 4 died under 2 years.

Remarks.

Any comments on these tables are made with all the reservations appropriate to dealings with small numbers.

(I) Total Deaths.

The expected deaths have been estimated by applying to each age-group over 5 the average annual death rate for these age-groups which obtained for the whole district during the period 1914-18, and by assuming that each person was under observation for the average period of 7.7 years. For those in the Minus and 0-5 groups, the average period of exposure to risk has been taken at 7.7 years, and the number of deaths has been calculated by tracing those alive at each year of life under 5 to the end of the average period of exposure. The death rates used for each year under 5 were those obtaining for the whole country during the period 1911-14, and the resulting figure is probably a fair approximation. The expected deaths numbered 90, compared with 136 actual deaths.

(II) Deaths ascribed to Tuberculosis.

Of these, 34 were due to pulmonary tuberculosis, and 15 to non-pulmonary forms. To what extent the latter may be due to bovine infection is not known. "The great majority of the fatal cases of tuberculosis in man are caused /

caused by the human type of tubercle bacillus. This majority has been roughly estimated at 94%. The remaining 6% of the fatal cases are caused by the bovine bacillus". (Cobbett (6)).

Deaths from all forms of tuberculosis among contacts represent 36% of the total deaths as compared with an average of 9.5% for the whole district, the ratio being 3.8 to 1.

The expected deaths from pulmonary tuberculosis among contacts, calculated by applying the average annual death rate from phthisis (1914-18) for the whole district and corrected for age distribution numbered 5.9, compared with 34 actual deaths. The ratio of actual to expected deaths is 5.7 to 1.

The number of deaths ascribed to tuberculous meningitis is sufficiently great to represent a true excess. Of 10, so certified, 7 occurred among babies born in homes which were already infected, and 2 in children exposed under 2 years of age.

(III) Deaths ascribed to other Causes.

The excess of actual deaths over expected deaths is not wholly accounted for by the increase in deaths ascribed to tuberculosis, and it is possible that erroneous certification may partly explain the difference. The correcting influence /

influence of hospital certification was certainly observed in 3 cases. A child notified as suffering from diptheria proved to have a retropharyngeal abscess secondary to spinal caries. Two cases of notified cerebro-spinal meningitis proved to have tuberculous meningitis. It will be found that the Infantile Mortality Rate is considerably increased, and it is in young infants that difficulties and errors in diagnosis chiefly arise.

Of suspect deaths there may be mentioned 8 due to meningitis (not tuberculous); 10 due to pneumonia (7 in the Minus Group); 6 to marasmus; 6 to enteritis; 1 to otitis media ? cerebral abscess. The death certified as parturi-:tion Bronchitis was the subject of a very suggestive history.

It will be noted that the suspect "bronchitis" of the older contacts does not appear in the death certificates.

(IV) Deaths in Relation to Age at Exposure.

Of 100 babies born in homes already infected, 41 died; and of 177 infants exposed to infection under 2 years of age, 54 died. Armand Delille (18) found that if children remain at home with tuberculous parents, the tuberculosis morbidity is 60% and the mortality 40%. Comby (19) showed a mortality of 50% among young children born of phthisical parents.

There /

There is a sharp rise in the death rate among contacts exposed at ages 10-20, at which period the normal death rate is almost at its lowest. Of 308 such contacts, 27 died, and 26 of the deaths were recorded at ages under 25 years. The certified causes of death were Pulmonary Tuberculosis 16; meningitis (unqualified) 1; abortion - peritonitis 1; appendicitis 1; influenza 1; acute rheumatism 1; violence 3; killed in action 1; unknown 2.

It cannot be said whether this incidence of pulmonary tuberculosis is to be ascribed to primary massive infections of non-infected persons or to super-infections provoking the phenomenon of Koch in previously infected subjects (Calmette) or to a coincidence with the period at which the predisposing causes ordinarily assert themselves, but it is a fact that contacts at these ages appear to be specially liable to contract fatal phthisis.

(V) Deaths in Relation to Age at Death.

During the period of observation there were registered 100 births and 32 deaths of infants under one year, equivalent to an Infantile Mortality Rate of 320, compared with an average rate of 110 for the whole district during the same period.

Of the total deaths 21% occurred in the age period 15-25, compared with 5% for the District, and this in spite of /

of the fact that the proportion of contacts living in this age-group was below that of the general population.

THE ADMINISTRATIVE ASPECTS OF THE OBSERVATION OF CONTACTS.

If it is accepted that a system of observation is desirable in view of the increased prevalence of tuberculosis among contacts, it remains to be considered in what form this is practicable. The 50% morbidity of Thompson is deceptive. At first sight it suggests an immediate and striking reward for the observation of contacts in the form of many "early" cases of phthisis. It was constructed, however, from family histories extending backwards over a number of years, sufficiently great to exclude the probability of any then alive showing evidence of the disease at a later date. If the earlier diagnosis of all the subsequent cases which may occur among those exposed to infection is to be attained by a system of observation of contacts, the period of supervision must be equally prolonged. This is obviously an administrative impossibility. Any practical scheme will therefore be "incomplete", and the results in so far as they relate to the earlier diagnosis of undoubted phthisis, will be disappointing in proportion to the incompleteness. It has been shown, for example, /

example, that after an average period of almost eight years, 28% of the contacts have not yet entered the danger zone of 15-35, and only 26% are over 35 years of age.

40 families out of 210 were invaded and 49 persons out of 1162 were attacked with definite pulmonary tuber-:culosis. No considerable proportion of the others were found to have undoubted phthisis. The incidence rate was high, but the actual numbers were not great. The suscepti-:bilities of the more numerous survivors and their willingness to be supervised will demand consideration. 46% survived the "first date of exposure" by more than 8 years. They were certainly not invalids and the great majority were undoubtedly in good health. If at a future date some develop phthisis from the reactivation of a latent lesion, there are no means available at present to detect them, and it would be a happy coincidence if a visit of supervision should be paid at the opportune moment. Much may be done by education to overcome the careless disregard of premonitory symptoms, but an excessive insistence on the dangers will produce divergent results. Repeated alarms due to non-tuberculous minor ailments may depress the sensitive subject; and by inducing a feeling of false security among those who are indifferent lead to the very results which the warnings were designed to avoid.

The /

The most favourable opportunity for examining contacts is at the date of notification, and supervision is readily maintained during the lifetime of the patient. Table IV shows the intervals which elapsed between the notification of the first case and the onset of symptoms of those who were subsequently discovered to have "definite" pulmonary tuberculosis.

TABLE IV.

Year of Notification.	Number of Cases.	Total Contacts.	Contacts Subsequently found to have Phthisis.	Interval in years between onset of symptoms of subsequent cases, and notification of first case.								
				Prior	-1	-2	-3	-4	-5	-6	-7	-8.
1911	14	74	6	-	-	2	-	1	-	2	-	1
12	17	101	5	1	1	1	-	-	-	1	1	-
13	27	164	8	2	-	1	-	2	1	-	2	-
14	22	121	7	2	1	-	2	1	1	-	-	-
15	18	86	2	1	-	-	-	-	-	1	-	-
16	21	105	6	-	1	1	-	1	2	1	-	-
17	16	100	2	-	-	-	-	-	-	2	-	-
18	16	92	6	5	-	-	-	1	-	-	-	-
19	19	103	3	-	-	1	2	-	-	-	-	-
20	24	125	2	1	1	-	-	-	-	-	-	-
21	16	76	2	-	2	-	-	-	-	-	-	-
TOTALS --	210	1147	49	12	6	6	4	6	4	7	3	1.

The "contacts" are those named in the first visit card, and any who became resident in the household at a later date during the lifetime of the person who had phthisis. The "onset of symptoms" is the date given by the patient, and checked by the observations of medical officers and nurses. It has the merit, at least, of representing the earliest date at which the person was likely to seek medical advice or submit to examination.

It will be noted that 12 of the subsequent cases were suffering from symptoms of their illness when the family first came under observation; 12 complained within two years; and 11 did not complain for more than five years.

In 26 instances it was found that subsequent cases showed symptomatic evidence of tuberculosis during the lifetime of the first case, and in the remaining 23 the intervals which elapsed between the death of the first and the onset of symptoms of the subsequent case ranged from two months to seven years.

Theoretically, then, rather less than one quarter of the subsequent cases might have been diagnosed when the family first came under observation, and rather more than one half during the period of home visitation by the official staff.

TYPE OF DISEASE AMONG SUBSEQUENT CASES.

The /

The average age at onset was 23.3 years, and 29 were under 20 years of age, and 38 under 25.

Of those who died the total duration of illness was under 6 months in 6 instances: from 6-12 months in 10: from 12-18 months in 7: and over 2 years in 11. Of those who are still alive 2 have fibroid phthisis, 7 chronic phthisis, and 6 a sub-acute type of disease with a bad prognosis. That is to say, the disease was acute or sub-acute in 29instances, and chronic in 20.

An earlier age at onset and a more acute type of disease was shown by Reginald Thompson (12) in a compari-:son of 2000 cases of hereditary phthisis, and a similar number of acquired phthisis.

Of those who proved to have chronic phthisis, it is possible that an earlier diagnosis within the period of illness as stated by them could have been made and effective treatment instituted, but of the larger group in whom the disease was acute or sub-acute, the prognosis at the onset of symptoms as given by the patient was almost hopeless. Many of these are cases in which the earliest possible diagnosis is not a diagnosis of early disease. With them diagnosis and treatment to be effective would have to precede the symptoms which they regard as the onset of their illness.

There /

There are, however, cases in this group who had no warning, and the relatives have not been shaken in their testimony to the outstandingly good health which preceded the fatal illness. It was, in fact, frequently observed in the course of these enquiries that among young subjects tuberculous disease often picked out the healthy ones, and left apparently untouched, those who had been "delicate" and difficult to rear. Calmette (4) remarks that the question of the "tuberculisable soil" has been obscured by certain clinicians who still regard as "candidates for tuberculosis" those who present the characteristic stigmata of the disease. These he finds are in reality "des bacillises", and when not exposed to frequent or massive re-infections acquire the state of immunity appropriate to the carriers of latent lesions.

A proportion of the acute and sub-acute cases had premonitory symptoms, but these were often of a trifling character, and did not interfere with the day's routine. Of more than half the subsequent cases then, it would seem that some cannot be diagnosed at a stage sufficiently early in the course of the disease to lead to effective treatment, and others will be discovered only by referring trifling complaints to their medical attendant. Eleven of the cases

in /

in this group were under 14, and subject to routine examination at school: 16 were between the ages of 14 and 25, and willingly, in my experience, to accept advice from nobody. Many patients will not seek attention even at the onset of their illness as they regard it, and it is doubtful if any propaganda would induce them to recognise the minor premonitions as worthy of a medical examination. Any successful scheme of observation of contacts must result in the examination of many persons with trifling ailments, for accompanying those whose symptoms are the true precursors of phthisis will be many in whom similar symptoms are due to benign causes.

The conclusion is that probably not more than one half of these subsequent cases might have been discovered at a stage in the disease at which treatment might have proved effective, and that even this could only be achieved by a more enlightened interest in their health on the part of the contacts, and by a fine diagnostic discrimination on the part of the physician.

THE IMPRESSIONS FORMED ON VISITING THE HOMES OF CONTACTS are briefly described. In only one instance was information refused, but in many where the patient had died, the enquiry was not well received. The histories in so far as they relate /

relate to deaths are probably accurate, but are of doubtful value with reference to the health of contacts. A mother ridiculed the object of the visit, and insisted that her children were quite healthy. Three weeks later, a girl aged 15 was examined by the school medical officer, and found to have advanced phthisis. She died within 5 weeks of the date of the visit of enquiry. This was the third death from pulmonary tuberculosis in this family within nine months, and the contacts refused to be examined. Concealment of symptoms is probably not uncommon, and no system of observation will extract an account of them. "The selection exercised by the assured (as between whole life assurance and endowment assurance) is a most potent factor and practically of equal importance to the medical selection", (Rusher and Kenchington). Repeated visits to households in which the inmates profess good health will provoke active resentment. Continuity of observation after the death of a patient may be secured by notification of a suspect child. The routine examination of all contacts is not practicale, and children should be specially examined at school as suspects up to the latest possible age. Adolescents, amongst whom an examination is especially desirable, are largely beyond control, and advice, and it might be advisable to transmit the family hiatory /

history to their medical attendant for record on the history sheet of those who are insured.

CONCLUSIONS.

(1) The incidence of tuberculous disease amongst contacts is definitely increased and the ratio is probably not less than 4 to 1 of the general population.

(2) Amy practical system of observation of contacts will be incomplete, and the number of cases of definite pulmonary tuberculosis which will be diagnosed at an early stage in the disease is likely to prove small.

(3) An earlier diagnosis may be made in a proportion of cases of chronic phthisis and a considerable number of tuberculised children will be found.

(II) THE SELECTION OF CONTACTS FOR FURTHER EXAMINATION BY THE APPLICATION OF THE DREYER CO-EFFICIENTS OF PHYSICAL FITNESS.

It has been shown that a system of observation of contacts is desirable and within limits is likely to prove practicable and lead to earlier diagnosis in a proportion of cases. It has also been shown that in a successful scheme many will present themselves with trifling complaints and indefinite physical signs and the tendency will be to over-

weight these vague illnesses and signs with the burden of the patient's pedigree. The assessment of physical fitness by means of the Dreyer co-efficients appeared to offer the correcting influence of an exact scientific measurement. In the prognosis of pulmonary tuberculosis the method is of proved value (Dreyer and Burrell (20, and Cameron (21)) and many of the problems in the examination of contacts are in reality those of prognosis. Especially is this true of the children whom Calmette calls "des bacilleses" and of abortive phthisis in adults. As an aid to diagnosis Dreyer and Burrell conclude that "even a single examination, but more especially a repeated examination of the vital capacity of doubtful cases will prove useful. If a normal V.C. is found this patient is most unlikely to be suffering from pulmonary tuberculosis, whereas, if the V.C. is much decreased, this patient should be suspected".

It was with the limited object of testing the value of a "single examination" as a means of selecting contacts for further observation that these investigations were made.

(A) THE EXAMINATION OF 100 CONTACTS.

The contacts were drawn from 100 of the families dealt with in the previous part of this paper, and every encouragement was given to attend, including appointments at fixed hours /

hours, a personal explanation of the value of determining physical fitness, and the avoidance of any reference to tuberculosis. Excluding children under 8, the possible number available was approximately 450 and the number who attended was 111 (including 7 children under 8. A considerable proportion of those who were induced to attend have declared against further observation.

The weight and vital capacity were determined according to the methods described by Professor Dreyer (22) and the results are expressed as percentages of the normal. At the same time, the cases were submitted to a careful clinical examination.

RESULTS OF THE EXAMINATIONS.

There are excluded 7 children under 8, 3 adults over 50, and one female adult who bordered on hysteria.

In the accompanying Table the remaining 100 cases are divided into age groups.

TABLE V.

100 Contacts classified according to Age and Vital Capacity.

Age Groups.	No. of cases.	VITAL CAPACITY.						
			Diminished.					
		Normal	-5%	-10%	-15%	-20%	-25%	Over 25%
8-12	36	12	6	5	7	5	-	1
12-15	30	10	7	9	1	1	-	2
Over 15	34	12	6	7	4	2	-	3
All Ages	100	34	19	21	12	8	-	6

The reliability of the vital capacity readings was found to vary with the age of the subject, at least, in so far as intelligence varies with age. Dreyer (23), excludes children under 8 as unreliable, and adults over 50 in so far as the tables given are not strictly applicable to them. Hutchinson (24) shows no records of persons under 15.

The cases are also grouped according to the degree of vital capacity deficiency. "It can safely be stated that if a person is found to have as much as 10% less vital capacity than is normal for his class, it is probable that he is suffering from some health depressing condition, and if he is as much as 15% below the normal limit, it is practically certain that he is abnormal in this respect". (Dreyer).

The cases are briefly described in the groups into which they were classified by the V.C. findings.

V.C. DIMINISHED BY MORE THAN 25% (6 cases).

(1-3) Three of these cases had definite tuberculosis - one had fibroid phthisis; one had multiple caseating glands and a mass in the hilus producing pressure phenomena; and one had complete collapse of the left lung with signs of a healed cavity. (V.C. - 54).

(4) A /

(4) A boy aged 14½, was said to be well when the home was visited. Later, a history was given of recurrent cough, and pain in the left side, of five months duration, and of recurrent conjunctivitis with photophobia. The physical signs were - pleural friction over the right apex, coarse moist rales over right upper lobe behind, scattered rhonchi over left lung and exquisite tracheophony to the 5th dorsal vertebra. The sputum and X-Ray examinations were negative but the combination of symptoms and signs was noteworthy.

(5) A girl aged 11 complained of recurrent cough of many years duration, and was always "delicate". She was running about freely at the date of examination. There were signs of a unilateral bronchitis, relative dulness at the right apex and exquisite tracheophony to the 5th dorsal vertebra. X-Ray examination showed right hilus affected and haziness of both apices, especially the right.

(6) A woman aged 24, said she was quite well. She was profoundly anaemic and looked ill. The chest signs were indefinite and she refused X-Ray examination and the further observation which her general condition demanded.

VITAL CAPACITY DEFICIENT 15% - 20% (8 cases).

(1-2) Two cases had no definite physical signs but complained of /

of suspicious symptoms. One had a history of pleurisy eight years ago, and looked well. One complained of languor, anorexia, and cough following pneumonia a year before, and did not look fit.

(3-4) Two cases had phlyctenular conjunctivitis.

A boy aged 18 did not complain but did not look well. The chest signs were negative. There was a history of recent active conjunctivitis and a healed ulcer of the left cornea was present. He refused re-examination and observation.

A girl aged 12 complained of languor, cough, debility and "sore eyes". She was pale and did not look well. Chest signs were indefinite and X-Ray examination showed nothing but a few glands in the hilus.

(5-6) Two cases had tuberculous keratitis.

A girl aged 8½ did not complain. There was a history of recurrent sore eyes. She was healthy looking and well nourished. The physical signs were - both tonsils much enlarged; discrete interstitial opacities of both corneae; impaired percussion and loud blowing expiration in right interscapular space; exquisite tracheophony to 5th dorsal vertebra; rhonchi over both lungs and coarse rales at right base.

A girl aged 14½ had no complaint. There was a history /

history of recurrent sore eyes of several years duration. She was anaemic and did not look fit. The physical signs were - discrete interstitial opacities of both corneae; right tonsil much hypertrophied; rhonchi confined to right apex.

(7) A boy aged 8 was brought for examination by his mother who was evidently unwilling to give any information. He looked fit. The physical signs were - enlargement of both turbinates; exquisite tracheophony to the 5th dorsal vertebra; impaired percussion both interscapular spaces; coarse rales right upper lobe. It was possible that the V.C. reading supplied the history which the mother withheld.

(8) In one case the diminution in V.C. appeared to be due solely to nasal obstruction.

VITAL CAPACITY DEFICIENT 10% - 15% (12 cases).

(1-4) Unreliable readings were recorded in four children under 12, one of whom was deaf and dumb, and mentally deficient.

(5-6) One case had enlarged tonsils and adenoids with no other abnormality; and in one the tonsils had been removed a year before, and there was no evidence of bronchitis which had existed previously.

(7-8) /

(7-8) Two cases were suspects.

A boy aged 8½ was described by the mother as "touty". The mother had open pulmonary tuberculosis when he was born and the boy was "delicate" and had bronchitis until 3 years of age. He then contracted pneumonia and his cough disappeared. He was healthy looking and the physical signs were indefinite.

A female aged 39 complained of repeated attacks of influenza and cough. Coarse moist rales were audible over right upper lobe. There were no other abnormal physical signs.

(9) A boy aged 16 recently began work as a collier and his physique did not justify his choice of occupation. There were no abnormal signs in the lungs.

(10) One case illustrated the fallacy due to excessive carpulence. A woman aged 27 had a standing height of 5 feet 2 inches and weighed 11 st. 6 lbs. without clothes. The excessive fat covering the thorax resulted in such a high theoretical standard of weight and V.C. that the final calculations showed a deficiency of 1% and 14% respectively. Such an obvious abnormality cannot be taken as invalidating the reasonable application of the Dreyer co-efficients "The examination /

examination of corpulent persons must not be compared with those not corpulent" said Hutchinson who allowed the normal weight to be exceeded by 7% before adjusting the result.

(11-12) Two cases showed no apparent cause for deficiency.

VITAL CAPACITY DEFICIENT 5% - 10% (21cases).

(1-5) Unreliable readings were recorded in five instances - 3 children under 12; 1 nervous woman; 1 girl who could not be made to understand.

(6-7) Obstructive enlargement of the tonsils and adenoids were present in 2 cases, one of whom had otorrhoea.

(8-11) Moderate hypertrophy of the tonsils was noted in 4 cases, one of whom had otorrhoea, and 2, signs suggestive of tracheo-bronchial adenopathy.

(12-16) In 5 instances a provisional diagnosis was made as follows - tracheobronchial adenopathy: suspect pulmonary tuberculosis: asthma and bronchitis: chronic dyspepsia: puerperal debility. They deserve further investigation, but it is doubtful if they will return.

(17-18) /

(17-18) In one case the diagnosis was, arrested spinal caries, and in another, rachitic deformity of the chest.

(19) The case of a girl aged 15½ was of much interest. Three weeks after the examination she had a brisk haemoptysis and a few days later tubercle bacilli were found in the sputum. The comparatively small deficiency in V.C. (-8.1%) had not attracted special attention and although the weight was also deficient (-7.8%) the record of the examination showed that she was poorly clad, generously flea-bitten, and had abundant nits in the hair - indications of a sufficient cause of poor nutrition. There had certainly been nothing outstanding in the record of physical signs.

(20) There was a case of importance in view of the administrative action which had been taken. A girl aged 20 was a suspect in 1912 and had then indefinite physical signs in the chest. With a history of being well for several years and in the absence of any abnormal signs her name was removed from the register. It will be a matter for consideration whether the procedure was justifiable with V.C. readings —6.5% and -8.4%.

(21) In one instance there was no apparent explanation of the deficiency.

VITAL CAPACITY PLUS, NORMAL, AND LESS THAN 5% DEFICIENT (53 Cases).

Obstructive hypertrophy of the tonsils was present in 5 cases, in one of which there were signs suggestive of enlargement of the bronchial glands.

A provisional diagnosis of tracheobronchial adenopathy was made in 5 cases and in 2 the children complained of cough, anorexia and debility.

In 8 instances symptoms were present, but with the exception of the two children mentioned, the physical signs were not sufficient to justify even a possible diagnosis of pulmonary tuberculosis.

In more than half the cases minor and indefinite signs were present singly or in combination.

REMARKS.

(I) UNRELIABLE RESULTS.

Vital capacity being the greatest voluntary expiration following the deepest inspiration, it is clear that the will of the person examined can materially influence the result. Deficiences in V.C. have been regarded as unreliable in those cases where the indicator of the spirometer stopped suddenly at the final reading in the course of a rapid revolution and where there were wide variations in successive readings taken at one sitting. It /

It was uncommon to find children from ages 8 to 12, who would repeatedly perform the expiratory act in the proper fashion and in many instances one was compelled to await the record of the maximum effort performed with sudden force and by chance. In adults, the five successive observations suggested by Dreyer proved to be sufficient, but it was not found possible to limit the number in children, many of whom required 20 and 30. Sufficient intervals were allowed, and in some cases, the examination was continued over two days, in an endeavour to secure the maximum expiration. The results, however, are those of a "single examination" in that repetitions were designed to avoid and not to record changes in circumstances. As examples of violent alterations in the V.C. readings there may be quoted three cases of children under 12 by whom results of -28 and -6; -24 and -2; -15.6 and normal, were recorded, after 36, 30 and 24 observations respectively. It is a point of practical importance that children should not be examined in the presence of a third person, because of their tendency to solicit approval of their efforts before these are completed.

Difficulty was experienced in inducing some children to assume the erect posture, and failure to do so may lead to a diminished vital capacity. A condition of temporary kyphosis /

kyphosis and laxity of the abdominal wall, due to loss of muscular tone may be observed in many of the chronic toxaemias of childhood.

The association of a general poor air entry on auscultation and deficiencies in vital capacity less than 10% was noted in some cases, and was thought to be due to a protective restriction of the respiratory range practised by children who live in close, ill-ventilated houses.

In adults, and especially amongst females, nervous-:ness may lead to a false result. The extreme example of this was the case of a woman whose inability to distinguish between expiration and inspiration threatened to wreck the spirometer and imperilled her own nervous system.

The hour of examination in relation to work and food was found to have a considerable influence and in one case a + 3.7 V.C. was converted into a -4.7 by the intervention of a good meal.

Difficulty in measuring the chest was experienced with children, and especially amongst boys, the production of the measuring tape resulted in an inflation of the chest which persisted throughout this part of the examination, and the subjects would even maintain a conversation in a gasping and semi-asphyxiated condition. In female adults it is essential that /

that the tape be placed in position at the level at which the measurement is to be taken and fixed there by an assistant before moving it under the breasts. By this method, subsequent measurements will be found to show only slight variations.

It is necessary to eliminate unreliable results due to these causes before ascribing a deficient V.C. to any abnormality. These errors occur chiefly among children under 12: they do not account for deficiences over 15% and rarely over 10% in the final results and may be largely excluded by taking a sufficient number of observations.

(II) ENLARGEMENT TONSILS and ADENOIDS.

In only one instance was the V.C. diminished more than 15%, and in this case a probable diagnosis of tuberculous tracheobronchial adenopathy was also made. Only two cases showed a deficiency over 10% and in 5 instances the V.C. was plus, normal, or less than -5%. Two cases with perforation of the membrana tympani had V.Cs. -9.8% and -5.4%.

These results are of importance in view of the fact that probably no single condition so closely simulates tuberculous tracheobronchial adenitis as chronic hypertrophy of the tonsils and adenoids. The symptoms may be identical and /

and the signs of a concurrent simple mediastinal adenitis, secondary to a descending infection, differ in no way from those of a tuberculous glandular infection. In one case, the disappearance of D'Espine's sign was noted a year after the tonsils and adenoids were removed, and the V.C. was +1%. In the case where signs of enlarged bronchial glands were present and the V.C. was -16% there co-existed a tuberculous keratitis.

(III) PHYSICAL SIGNS PRESENT.

Few cases failed to present one or more of the numerous deviations from normal described as occurring in tuberculous disease. Many of the signs were insignificant by themselves but associated with a definite history of exposure to infection they tended to assume a more formidable appearance. When measured by the standard of V.C. deficiency 14% were in the "practically certain" group, and 12% in the "probable" group. Deficiences of 5% to 10% have been regarded as "possible" and the others as normal.

In children, the difficulties of establishing a diagnosis are almost insuperable. "The best that can be said about the physical diagnosis of tracheobronchial adenopathy is that it is very indefinite" (Fishberg). X-Ray examinations, in my experience /

experience, have been indefinite and variable. Amongst other clinical indications, considerable reliance has been placed in D'Espine's sign in cases where the whispered voice was exquisitely heard to the 4th dorsal vertebra or lower. Only four such cases had a V.C. diminished by more than 10% and two of these showed definite signs of bronchitis, and one had a tuberculous lesion elsewhere.

(IV) SYMPTOMS PRESENT.

The advantages of an impartial assessment were again apparent. "Neurasthenia and debility" in the husband of a phthisical wife was corrected by a V.C. + 11.7%. The wife of a consumptive husband complained of rheumatism in the right shoulder, cough, night sweats, and general debility, and sought extra nourishment for the treatment of these complaints. The physical signs were negative, and the V.C. + 8. The father of a girl who died of phthisis complained of chronic cough and asthma, and had a V.C. -8%, and no evidence of tuberculous disease. A male adult contact with "asthma and bronchitis" had a + 3 V.C. A woman aged 38 who nursed her brother-in-law for many months when he was dying of phthisis complained of general weakness. She was listless looking, and somewhat hectic in appearance, but there were no abnormal physical signs in the chest. The /

The V.C. was + 14%, and she was in reality suffering from the effects of overlactation, and repeated pregnancies at short intervals.

Conversely, persons who said they were well were found to have a deficient V.C. and o_f two in whom the deficiency was more than 15%, the general appearance of the subjects belied their statements.

(V) VITAL CAPACITY FINDINGS AS AN AID TO DIAGNOSIS.

It is not claimed by those who introduced or have used the Dreyer co-efficients that any mechanical contrivance or mathematical formula will solve the essential problems of differential diagnosis, and it would be absurd to believe that the results of a single examination might be so used. Nevertheless, the readings recorded in cases showing enlarge-:ment of the tonsils and adenoids are of interest in this respect. Also, it is unlikely that pulmonary tuberculosis could masquerade as asthma and bronchitis and record a normal V.C. or a deficiency of less than 10%. It is not contradictory to find the disease manifesting itself by a frank haemoptysis in a young adult three weeks after an examination which registered a V.C. only deficient by 8.1%. The probable extent and activity of the lesion in these cases as indicated by the prognosis /

prognosis suggest the explanation of the comparatively small diminution. Nevertheless, one can imagine what might have happened to this girl if she had not had the good fortune to have a spitting of blood and the signi-:ficance of deficiencies less than 10% must be considered.

CONCLUSIONS.

(1) There are causes of unreliable findings, common in children, which must be excluded before the results have any significance.

(2) The vital capacity was not diminished by more than 10% in the case of a girl who had a positive spit three weeks later.

(3) Early re-examination was indicated in all cases in which the V.C. was deficient by more than 15% with the exception of one in whom there was an apparent cause for the result other than tuberculosis.

(4) The exclusion of 53% of the cases, in whom theV.C. was plus, normal, or less than 5% deficient, as not suffering from active tuberculosis and not requiring immediate re-examination appeared to be justified by a consideration of all /

all the available evidence.

(5) Of those in whom the V.C. was deficient by 5% to 15%, the need for early re-examination will be determined by the degree to which the clinical manifestations suggest tuber-:culosis, and by the presence or absence of a cause, other than tuberculosis, sufficient to account for the result. In this group, especially, the extent to which the weight varies from the normal will be an important factor in deciding on future action.

(6) The actual diagnosis will only be arrived at by a consid-:eration of all the features of the case.

(B) THE EXAMINATION OF 84 CASES OF TUBERCULOSIS.

This part of the enquiry was undertaken for the purpose of controlling the above results by the examination of 84 persons who were known to be tuberculous, or had been under observation for some time as suspects.

It is not proposed to give a detailed description of each case, but rather to describe the general results and the features of any cases specially interesting from the present point of view.

In the accompanying table, the cases are classified according to the nature of the disease and to Vital Capacity.

TABLE VI.

Nature of Disease.	Total.	VITAL CAPACITY.						
		Normal	0-5%	-10%	-15%	-20%	-25%	Over.
Pulmonary Tuberculosis.	20	1	2	-	4	5	2	6
Other Tuberculous Diseases.	14	7	2	3	-	2	-	-
Tracheobronchial Adenitis.	12	1	2	2	-	2	1	4
Pleurisy.	6	4	1	-	-	-	-	1
Suspect Pulmonary Tuberculosis.	3	-	2	-	-	-	-	1
Bronchitis.	8	-	-	3	4	-	-	1
Tonsils & Adenoids Nasopharyngitis.	10	3	2	2	2	1	-	-
Other Defined Diseases.	2	-	-	1	1	-	-	-
Not yet Diagnosed.	2	-	-	1	-	-	-	1
No Apparent Disease.	7	1	3	2	-	1	-	-
	84	17	14	14	11	11	3	14.

UNRELIABLE RESULTS.

A possible source of error was illustrated by the case of a man aged 48 who suffered from fibroid phthisis. He had complained of cough for nine years, the physical signs were vague, but an X-Ray examination had revealed fairly marked fibrosis of both apices. At the date of the examination, he still had cough and spit and complained of recurrent debility which compelled him to spend a day in bed occasionally. The V.C. was found to be diminished by only 2.6%. The expiratory act was so forced and so sus-:tained that four observations and sufficient intervals for recovery occupied 25 minutes. After the fourth reading, the patient was faint, perspiring, and exhausted and asked for water.

Unreliable readings resulting in an excessive diminution of V.C. will lead to re-examination, and correction, but when the very excellence of the effort flatters the actual physical condition, a real deficiency might escape notice. This case and others, similar if not so striking, impressed one with the considerable variations from "normal" which must exist among persons of apparently similar classes, and readily supported the conclusions of Myers (24) that spirometer readings are most valuable in individuals whose normal capacity has been established /

established at some time when they were in good health, and in following the course of the disease after the diagnosis has been established. Fortunately, however, as in the above case, these abnormal efforts are likely to be recognised, and adjusting their own normal, the authors will be judged in the light thereof.

Another man with fibroid disease, who was urging his claim for early re-admission to Sanatorium, exemplified the possibility of the converse error. It was easy to observe his lack of effort, but the actual intention thereof was rendered doubtful by his state of mental deficiency.

It was observed that women who were not nervous could perform a prolonged expiration with less apparent effort than the majority of men, and for this reason the readings were wrongly regarded with suspicion on occasions.

The super-expiration and the lack of effort can be easily recognised and assessed at their special value.

PULMONARY TUBERCULOSIS - 20 Cases.

The case in which the Vital Capacity was normal presented features of interest. He was a discharged soldier aged 28, who was gassed in 1916 and had his left arm amputated at the shoulder in 1917 as a result of wounds. In 1920, there were indefinite /

indefinite signs confined to the left apex. He received no special treatment and was able to go about freely. At the date of the examination he complained of cough and spit, but was otherwise fit and looked well. There were no abnormal signs in the chest, the X-Ray examination was negative, smears from four specimens of sputum were negative and the V.C. was +3%. The conclusion reached was that there was no evidence of pulmonary tuberculosis. A guinea-pig was inoculated, and six weeks later was found to show marked evidence of tuber-:culosis. All the clinical evidence suggested that the lesion must be limited, and of low activity, and he is rather a carrier of tubercle bacilli than a subject of tuberculous disease.

One of the cases in which the V.C. was diminished by less than 5% has already been described. The other was a male aged 23, who was examined three weeks after his illness began with a sudden haemoptysis in the midst of good health. The spit was positive, but he looked fit, did not complain, and there were no abnormal physical signs. The V.C. was -2.9%. It is significant that many cases of this type show no abnormal physical signs and frequently no discernible X-Ray abnormalities, but have tubercle bacilli in the sputum, and it is reasonable to assume that other cases, without haemoptysis, will be detected at the same stage by the same method. The clinical features, the/

the prognosis, and the V.C. findings suggest that many of these are cases in the early stages of the disease, and the method by which an exact diagnosis may be made is of importance.

These three cases and the young female contact to whom reference was previously made, were the only examples of known definite pulmonary tuberculosis in whom the V.C. was diminished by less than 10%. In two the disease was clinically quiescent, with fairly marked fibrosis in one, and no evident fibrosis and a positive spit in another. In the other two, there were no signs of systemic disturbance, the lesion could not be detected by physical examination, and tubercle bacilli were present in the sputum. Of the latter, cases, it cannot be said, however, "that the disease is of no clinical significance" although it is readily admitted that many persons affected to a similar degree but not revealing the diagnosis by a frank haemoptysis must escape notice and cure themselves. It does not seem that the V.C. will detect such cases, but then an examination of the sputum may.

J.A. Myers (24) found that in some cases of fairly extensive fibrosis and calcified tuberculosis, the lung capacity was within normal limits: and, in spite of his conclusion /

conclusion that in most cases the V.C. was sufficiently reduced to indicate impairment of function if the disease was of clinical significance, his tables show that of 69 cases of parenchymatous tuberculosis, 7 had a normal V.C. and 3 of these had bilateral disease. Of 20 who had peribronchial tuberculosis, 8 had a normal V.C. and 3 of these had bilateral disease.

It is frankly admitted that the case of the young female contact was a grievous disappointment, especially after a perusal of Hutchinson's striking examples of V.C. diminution in similar circumstances.

Of 4 cases in whom the V.C. was deficient by 10% - 15%, the disease was of long standing, and quiescent in two instances and of recent origin and low activity in one. There were features of interest in the fourth case. A boy aged 19, first came under observation after a brisk haemoptysis in June 1920. He gave a history of pleurisy in 1918, and there were signs at both apices. He was urged to undergo treatment and refused, and thereafter worked regularly as a collier and played strenuous football every week, until the end of 1922. He was visited frequently by a member of the staff, and at a date in January 1923, was said by his mother to be in good health. He was re-notified

two /

two days later and it emerged that a fortnight previous, he had consulted his own medical attendant on account of a moderately profuse haemorrhage and had been informed within a few days that a specimen of his sputum was positive. The V.C. was 12% less than a Grade A normal, and the X-Ray examination showed fairly extensive disease of both lungs. The history and the V.C. suggest that in spite of his disease, there was no great impairment of the pulmonary function and the value of a system of observation was somewhat discounted by the nature of the information elicited at the official visit.

OTHER TUBERCULOUS DISEASES.

The nature of the cases and the V.C. findings were as follows:-

Number Of cases.	Nature.	Vital Capacity. Normal & 0-5%	Deficient 5-10%	Deficient Over 15%
1	Keratitis (Quiescent)	1	-	-
2	Glands & Keratitis(")	2	-	-
1	Cervical Glands (Active)	-	1	-
5	" " (Quiescent)	5	1	-
3	Multiple Scarring of Neck.	1	1	1
1	Multiple Bone Lesions (Arrested)	1	-	-
1	Abdominal Tuberculosis	-	-	1

The diagnosis in the case of abdominal tuberculosis was made in the course of a laparotomy, and the V.C. was affected by a small ventral hernia and very extensive scarring of the chest wall, due to a burn in childhood.

The case which presented multiple scarring of the neck and had a V.C. -18% showed no evidence of active tuberculous disease, but had valvular disease of the heart, apparently well compensated.

ENLARGEMENT OF THE BRONCHIAL GLANDS.

There were 12 cases in which a probable diagnosis of this condition was made. In 7 of these, the diagnosis was confirmed by X-Ray examination, and in 1, the result was negative.

The seven cases in whom the V.C. was diminished by more than 15% deserve remark.

(1-3) Two showed signs of associated bronchitis affecting both lungs, and one had a unilateral bronchitis which had been charted at intervals during the previous three years, always on the same side, and affectingthe whole of the lung. One of these children exhibited the habitus phthisicus and complained of cough and slumber sweats following pleurisy 5 years ago.

(4) /

(4) One was a woman aged 36 who came under observation in 1919, complaining of three attacks of pleurisy. She was then well nourished, anaemic, complained of facial neuralgia and had severe phorrhoea alveolaris to which her symptoms were ascribed in the absence of any abnormal chest signs. At a later date, there was pleural friction at the right apex and she complained of asthmatical attacks. An X-Ray plate showed a large glandular mass in the left hilus. At the date of the present examination, the chest signs were vague, and indeterminate, and she was not complaining. The V.C. was deficient by 31%.

(5-6) One boy had frank staining of the sputum and one was a case in which the X-Ray examination confirmed the diagnosis and showed a suspicious lesion at one apex.

(7) A girl aged 15 complained of recurrent cough and lassitude, following pleurisy 5 years ago. She had an attack of bronchitis affecting both lungs, and for two years remained in indifferent health. In March, 1922, there were signs of enlargement of the bronchial glands and of consoli-:dation of a small area at the lower angle of the left scapula. The diagnosis was confirmed by X-Ray examination. At the date of the present observation she was much improved, and /

and her mother was pleased with her condition. The V.C. was diminished by 18.5%. Tuberculin ointment for Moro's test was applied in error over a part of the chest wall which had been scratched by a pin, and a very violent reaction resulted. Without apparently associating the two facts the mother returned after a week to say that the girl was "bad" again, and showing all her old symptoms. In this case there appeared to be no doubt of the tuberculous nature of the enlarged bronchial glands.

These results suggest that a deficiency in V.C. over 15% in a case showing signs of bronchial adenopathy without bronchitis should be regarded with suspicion as being probably due to tuberculosis. The nature of the adenitis and bronchitis where the two conditions co-exist is a subject of difficulty. Tuberculous glands may occasion a concurrent bronchitis, while a simple bronchitis may give rise to a simple adenitis, always, however, liable to a super-imposed tuberculous infection. Repeated examinations of the V.C. in those cases, may afford some indication of the nature and progress of events although the effects of a non-tuberculous pulmonary fibrosis in producing a diminished V.C. will have to be considered:

PLEURISY.

Excluding /

PLEURISY.

Excluding cases dealt with under other headings, a history of pleurisy was given in 6 instances, and in one the V.C. was -33%. This was a girl aged 14 who recently came to the dispensary with a history of cough and debility following an attack of pleurisy three months previously. She was pale, emaciated and did not look well, and there were signs of a thickened pleura as high as the middle of the left scapula, but no signs of actual pulmonary disease. X-Ray examination confirmed the diagnosis, and showed no apparent evidence of invasion of the lung. Smears from the sputum were negative, but there is no doubt that the girl is suffering from something more than a simple chronic thickening of a serous membrane.

In the other five cases, the V.C. was normal or less than 5% deficient, and this was in agreement with their present physical condition. One of these was an adult who was notified and re-notified as suffering from pulmonary tuberculosis, and in whom no abnormal physical signs could be detected. Two of the cases were of interest as demonstrating the fact that the indications given by the V.C. have reference to immediate re-examination and not to future observation.

A boy aged 11 had pleurisy with effusion in 1921. Six months later, the cervical glands on the right side were affected, and after incision and scraping they subsided. Seven months afterwards a tuberculous iridocyclitis developed and four months later, submental adenitis. The V.C. was +6.5%.

Another boy aged 19 was examined in the dispensary in May 1920, and found to have pleurisy with effusion. He made a good recovery in hospital without paracentesis and resumed work after four months. In January 1922, he complained of pain over the right apex, and pleural friction was audible on auscultation. An X-Ray examination showed definite glandular lesions in both hili, but no invasion of the lung. He has been well since, and there has been no evident extension of the disease.

These two cases were rightly assessed as not requiring immediate re-examination, but the history of renewed manifestations of the disease certainly demands further observation.

SUSPECT PULMONARY TUBERCULOSIS.

In the two cases with normal V.Cs. the signs were those of a localised arrested lesion. In the third instance, the V.C. was -27%, and while the evidence of intra-pulmonary /

intra-pulmonary disease was quite definite and very suggestive of tuberculosis, the exact nature of the condition has not yet been determined.

BRONCHITIS.

Included under this heading are the cases of 4 children of ages 12-14 who have been under observation for more than three years, and in whom a probable diag-:nosis of non-tuberculous pulmonary fibrosis has been made. The X-Ray examinations were negative in two cases, and in one, thickening of the right lower lobe was found. The physical signs were at no time normal, and amongst others, consisted of areas of impaired percussion and poor air entry, and on occasions crepitations, all of which were apparently consistent with good health. From time to time there supervened an attack of bronchitis, but even this did not seriously incapacitate the patients as a rule. In these cases, the V.C. was diminished 7%, 13.3%, 14% and 15%.

A man aged 46, who suffered from severe bronchitis with asthma had a V.C. -49%.

TONSILS and ADENOIDS: NASOPHARYNGITIS.

There /

TONSILS and ADENOIDS: NASOPHARYNGITIS.

There were 6 cases of obstructive hypertrophy of the tonsils with adenoids, and 2 in whom the tonsils and adenoids had been removed by operation. The latter gave V.C. results of normal and -2%.

A boy who suffered from chronic nasopharyngitis without apparent adenoids had a V.C. + 4%. This case was also of interest in that he had been regarded as a contact for several years, although it ultimately transpired that the "infecting" person had syphilis and was not tuberculous.

A male aged 20 came under observation in 1920, complaining of morning cough with spit, and general debility. In 1919, he had suffered from two attacks of pneumonia. There were no abnormal signs beyond a poor R.M. all over, and some coarse moist rales in the left interscapular space. He had a severe nasopharyngitis and laryngitis. In 1921, an empyema of the frontal sinus developed, for which an operation was necessary. He suffered from recurrent attacks of nasopharyngitis, and laryngitis thereafter, but was able to follow his employment as a boiler-maker. The physical, X-Ray, and sputum examinations were negative for tuberculosis. The V.C. was -15.6%, and he had obvious nasal obstruction at the /

the date of examination. He was a notified case of pulmonary tuberculosis.

OTHER DEFINED DISEASES.

A man aged 34 had a foreign body in the lung, and an aneurism of the arch of the aorta. The V.C. was -11.7%.

A girl aged 20, under suspicion on account of failure to menstruate, had a V.C. -9.6% and suffered from atresia of the vagina.

NOT YET DIAGNOSED.

In these two cases, the patients recently came under observation and were evidently not well, but a diagnosis has not yet been established.

A woman aged 26 complained of cough with spit, following two attacks of pneumonia 2 years ago. There were no abnormal signs in the chest, the X-Ray and sputum examinations were negative, and the V.C. was -28%. It was thought there might be some error in the observations, and she was re-examined with a similar result. Beyond a poor air entry at the left base and scattered rhonchi, there were no abnormal signs, but she was noticeably dyspnoeic on exertion. There was no apparent disease of the heart. There was no doubt that the woman was ill and required care-

:ful /

careful and frequent examination, but unfortunately, she illustrated the practical difficulties of any system of observation by declaring that she would not attend again.

NO APPARENT DISEASE.

These were apparently healthy persons with the possible exception of a girl aged 14, who had chronic marginal blepharitis and showed evidences of considerable neglect. The V.C. was -8%.

A girl aged 10½ had a V.C. -19% and nothing to account for it. She was examined carefully on two occasions with similar results, and there was no reason to doubt the reliability of the V.C. readings.

CONCLUSIONS.

These results generally support the conclusions reached in connection with the examination of contacts which had reference to the selection of patients for immediate re-examination, and to the possible presence of active pulmonary tuberculosis.

A normal V.C. does not indicate that further observation of the person may be dispensed with, but in practice, it will be necessary largely to rely on such suspects to fix the date of re-examination by interesting themselves /

themselves in their own state of health.

It is doubtful if early lesions such as many of those disclosed by a sudden haemoptysis will diminish the V.C. to a degree sufficient to attract attention, and it would seem that fairly extensive pulmonary fibrosis is compatible with a normal lung capacity.

Other major and minor ailments, pulmonary and non-pulmonary, have been found to reduce the V.C. and deficiencies have been recorded in persons apparently in good health.

Spirometer readings are undoubtedly of value in the routine work of a tuberculosis dispensary, but it is not suggested that the results of this method of examination can outweigh the combined evidence of other diagnostic procedures.

Without repeating the arguments or stressing the reservations these final conclusions are offered:-

(1) The incidence of tuberculosis among contacts is definitely increased.

(2) A system of observation is desirable and within limits is practicable.

(3) The application of the Dreyer co-efficients of physical fitness is a valuable means of selecting contacts for observation.

REFERENCES.

(1) Final Report of the Departmental Committee on Tuberculosis, 1913. (Cd. 6641).

(2) Final Report of the Departmental Committee on Tuberculosis Appendix (Cd. 6654).

(3) Annual Reports C.M.O. Ministry of Health 1919-20, 1920 (Cmd. 978 and 1397).

(4) Calmette A., L'Infection Bacillaire et la Tuberculose 1920.

(5) The Collective Investigation Record, B.M.A 1883, quoted by Bulstrode H.T. Suppt. 35th Annual Report L.G.B. (Eng.).

(6) Cobbett L. Causes of Tuberculosis.

(7) Annual Report C.M.O., Co. of Lanark, 1911-22. Tuberculosis: Prevention, Detection and Treatment 1913.

(8) Newsholme A. Trans. Epidem. Socy. N.S. Vol. XXV.

(9) Reports to Med. Research Committee S.R.S. 18 & 46.

(10) Rusher E.A. and Kenchington C.W., Journ. of Inst. of Actuaries Vol. XLVII. 1913.

(11) Pearson, K. A first study of the Statistics of Pulmonary Tuberculosis - Drapers' Company. Research Memoir, 1907.

(12) Thompson, R.E. Family Phthisis, 1884.

(13) Annual Report C.M.O. Board of Education, 1919.

(14) Fishberg, M. Pulmonary Tuberculosis, 1919.

(15) Annual Report M.O.H. City of Aberdeen, 1909.

(16) Ward, E. Brit. Journ. of Tuberculosis, Jany. 1921.

(17) Schram, T. Tubercle Sept. 1922.

(18) Levinson. Med. Record, May, 1921.

(18A) Armand Delille - Second International Conference on Tuberculosis, London, 1921.

(19) /

REFERENCES (contd).

(19) Comby, Archives des maladies des enfants, Nov. 1905, quoted by Calmette (4).

(20) Dreyer G. and Burrell L.S.T. The Lancet, 1920, I. 1212, and The Lancet 1922, II 374.

(21) Cameron, C. Tubercle, May and June, 1922.

(22) Dreyer, G. and Hanson, G.F. The Assessment of Physical Fitness, 1920.

(23) Dreyer, G. and Hobson,F.G. - Annual Report C.M.O. Board of Education, 1920. Appendix C.

(24) Hutchinson, J. Medico-Chirurg. Trans. XXIX, 1846.

(25) Myers, J.A. Amer. Rev. of Tuberculosis, Jany. 1922.