

The Cause and Prevention of Pulmonary Tuberculosis in the
West Highland Rural Districts of Scotland

by

Duncan MacDonald MB., & C.M., (Glasg.) Ohan

Medical Officer of Health for Torosay, Mull, Argyllshire.

" Consumption! Terrible insatiable tyrant:- Who can arrest thy progress
or number thy victims ? Why dost thou attack almost exclusively the fairest
and loveliest of our species ? Why select blooming and beautiful youth,
instead of haggard and exhausted age ? Why strike down those who are
bounding blithely from the starting post of life, rather than the decrepit
beings tottering ^{to} its goal ? By what infernal subtilty hast thou contrived
hitherto to baffle the profoundest skill of science, to frustrate utterly
the uses of experience, and disclose thyself only when thou hast irretrievably
secured thy victim and thy fangs are crimsoned with its blood ? "

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The Cause and Prevention of Pulmonary Consumption in the West Highland Rural Districts of Scotland.

Before discussing the subject matter proper of this paper, it seems advisable to briefly review the more important points in the history of phthisis.

Although the exact cause giving rise to the disease remained unknown until 1882, when KOCH discovered the tubercle bacillus, still, from a very early period the symptoms of phthisis were well known to physicians, and its pathology up to a certain point, was also known and described by different authorities. From the earliest times it was recognised as a disease characterised by wasting or emaciation of the body, and seems to have first attracted attention about the 4th and 5th centuries B.C. At that time the knowledge of the disease depended entirely on external signs and symptoms. HIPPOCRATES who lived 400 years B.C. paid great attention to the sputum in lung diseases and noted that after blood spitting the discharge of purulent matter often followed, which brought on a consumption, and at last death. He recognised ulceration in the lungs after death. He also was cognisant of the fact that if treated early the disease was curable, but that diarrhoea attacking a person affected with phthisis was a mortal symptom. CALEN recognised its ulcerative tendency and as the ancients recommended the breathing of hot and dry air with the view of drying up the ulceration in the lungs, he advised his patients to go to TABIAE. He says of phthisis that it proceeds not always from a fluxion from the head but that excrements flow into the lungs sometimes from other parts. For it may so happen that a phthisis may be caused by an humour transmitted from other parts of the body.

The extant works of ARETAEUS } CIRCA appear to be the first to
A.D.150

contain more enlarged and careful descriptions of the disease, and he seems to have been the first to pay any attention to its pathology by recognising evidence of tuberculous nodosities in the lungs. When we come down to the 17th century we begin to find more evidence of the serious study of the pathological anatomy of phthisis, and in this century also a relationship was traced between scrofulous lymph nodes and caseous nodules in phthisical lungs. BONETUS described cavities and the sebaceous contents of granulations. In 1646 MANFETUS states that in the case of a young man who died from phthisis he found on post-mortem examination granulations in the lungs, liver, spleen, kidneys, mesenteric glands, and intestines, and he likened them to millet seeds and regarded them as tuberculous in character. He assumed that they arise from lymphatic glands and remarked that they were found in the tissues of man and animals. GREGORY in 1780 drew attention to the fact that a frequent and troublesome cough without any great haemorrhage or even without any haemorrhage at all may damage the lungs to such a degree especially if they be of a more tender structure than usual as to lay the foundation of a phthisis almost always incurable.

A new impetus was given to investigation in 1785 by THOMAS REID who regarded tubercles, not as enlarged lymphatic glands, but as the products of exudation. DR. BAYLE says (1793) "Tubercles are firm white bodies intersperded through the substance of the lung, and apparently formed in the cellular structure, for nothing like a gland is to be found in the cellular membranes of the lungs in a healthy state: and the follicles of the bronchiæ are not converted into tubercles, and are first very minute the clusters probably unite to form larger masses: the most common size is

is that of a garden pea: they are firmer in their consistence and often contain a portion of thick curdy pus. CULLEN said phthisis was due to (1) haemoptysis (2) a suppuration of the lungs in consequence of a pneumonia (3) a catarrh (4) an asthma or (5) tubercles, but that an abscess of the lungs did not necessarily give rise to it, but of the above enumerated causes phthisis most frequently arose from tubercles. Dr. SIMMONS informs us that he has had opportunities of inspecting the bodies of many people who died in this way and never found tubercles totally absent, and remarks that they are most commonly ^{formed} in consequence of a certain constitutional predisposition but whatever is capable of occasioning a morbid irritability of the lungs seems also to be capable of generating tubercles. He also saw them in subjects of different ages who had no symptoms of affection of the breast during lifetime. In these they were small and few in number. He adds that this fact proves that tubercles may exist in the lungs without inconvenience till they begin to disturb the functions of the lungs by their size and number or till some degree of inflammation be excited, either by accidental causes or by certain changes that take place within their substance, for as yet we knew but little of their true nature. BICHAT and LOUIS in the early part of last century recognised the fact that tubercle occurs primarily in the lungs in the case of adults. Louis wrote:- "Tubercles are tumours of yellowish white colour of dull aspect free from glossiness, and of variable consistence:- Tumours which soften after a certain time are evacuated into the bronchi and leave cavities of variable size in their room. They were always more numerous and/

* These were undoubtedly evidences of healed phthisis.

and more advanced at the apex than at the base of the lungs." LAENNEC regarded tubercle as a special organism or specific neoplasm growing according to laws of its own. He recognised three stages (1) the miliary consisting of small grey transparent tubercles, remaining separate and scattered through the lungs like millet seeds, and separable from the lungs: in fact a neoplasm which though in the first instance is attached to the tissues of the lung, still, does not destroy that tissue and does not give rise to general condensation. (2) the crude where miliary tubercles ran together forming avascular masses yellow in appearance and opaque and leaving less lung tissue permeable to air (3) the infiltrated not seen very definitely in either of the two former but appearing to infiltrate condense or block large portions of lung tissue, like the condensation of pneumonia. He believed these forms were evolved the one out of the other in the order mentioned and he looked upon the whole as an ulcerative and destructive process tending to necrosis. He also recognised that tubercles sometimes dried up and shrank and that Phthisis was cured by this method. It is doubtful if he recognised it as an infective disease, but he recognised a constitutional bias to the disease or a hereditary predisposition. He appeared to think that other affections of the lungs such as pneumonia or pleurisy could also lead to tubercle, and one would infer from his writings that he recognised a pretubercular stage. BROUSSAIS bitterly opposed these views of Laennec believing that the disease arose from an inflammation of the capillary blood vessels. LEBERT in 1848 claimed to have discovered a tubercular corpuscle which he described as a closely compressed angular body like a white corpuscle, not acted upon by reagents and having no distinct/

distinct nucleus or cell wall. He found them specially in miliary tubercles. VIRCHOW maintained that there was nothing specific about tubercle: that it was only an inflammation that had undergone caseation and asserted that such caseation occurred also in cancer and empyema. The caseation he thought gave rise to an infective element which caused the disease elsewhere. Writing on the subject of phthisis pulmonalis in 1855 NIEMEYER working on Virchow's ideas asserted that the disease arose from broncho pneumonia especially in young persons, and that it caseated and generated infective products. He said the first process was inflammatory and that the miliary tubercles were the result of caseation. The infective nature of tuberculosis was first demonstrated by VILLEMIN in 1865. He inoculated animals with tubercular products which was followed by a rapid development of tuberculosis in them. He was thus convinced of the infectious nature of the disease and stated " it was as infectious as small pox". Infection was denied by the Germans which gave rise to a controversy between France Germany and Britain. All three nations admitted that inoculation of tubercular material caused tuberculosis but maintained that there existed a predisposition in the animals and that inoculation of other inflammatory products gave rise to similar results. Villemin's experiments were confirmed by many observers among whom may be mentioned Lebert, Waldenburg, Klebs, Tappeiner, Bollinger, and Cohnheim. The last mentioned (Cohnheim) developed Villemin's experiments and obtained more definite results. He inoculated the transparent media of the eyes of animals, some with tubercular products, others with other pathological products, and some he left alone. By this method he demonstrated that tubercle was/

was distinctly infective producing always a specific result namely tuberculosis. In this country Dr. WILLIAM BUDD² of Clifton announced his belief that phthisis would be found to be contagious and led him to the conviction " that the deposits of tubercular matter are of the nature of an eruption and bear the same relation to the disease phthisis as the yellow matter of typhoid fever for instance bears to typhoid fever." and he announced his belief boldly saying " that by the destruction of tubercular matter on its issue from the body by means of proper chemicals or otherwise seconded by good sanitary conditions there is reason to hope that we may eventually and possibly at no very distant date rid ourselves entirely of this fatal scourge." Finally KOCH by his brilliant discovery of the tubercle bacillus in 1882 left no room for doubt as to the true and only cause giving rise to tuberculosis. He published in the Physiological Society of Berlin a note on the bacillus of tuberculosis, stating that he had found it in various forms of tuberculosis and that he had been able to cultivate it on media outside the animal body, and by inoculating it into animals he had been able to reproduce the disease. Experience has since shown that Koch's conclusions were well founded so that tuberculosis is now ~~an~~ admitted by all to be due to the presence of a germ (the tubercle bacillus) and ought to be a convincing proof of the purely infectious and therefore communicable nature of the disease. Medical opinion is not however in thorough agreement on the point of infection, some believing that the disease is transmitted, others that hereditary predisposition is an important factor in its aetiology. We may therefore/

therefore next Briefly consider the evidence in support of each of these views.

Heredity Some authors believe that phthisis is markedly hereditary the proportion of all cases in which it has descended from parents to children varying in the different classes from 12 to 20 per cent.

LANDOWZY and MARTIN inoculated the blood and tissues of a 6½ months foetus of a tuberculous mother which died six hours after being born, and presented no naked eye appearances of tubercle, into a guinea pig, and rabbits and caused tuberculosis in both the guinea pig and rabbits. WELCH opposes this view on account of the extreme rarity of tubercular disease in infants under one year of age. . As the bacilli may be found long before the actual formation of tubercle according to Koch, therefore although it is extremely rare to find evidence of coarse tubercular lesions in post mortem examinations on newly born children, still the bacillus may be found showing the presence of the disease. Similar results were obtained by inoculating the placenta and lung of a five months foetus from a woman dead of miliary tuberculosis. In animals veterinary surgeons have found newly born calves suffering from tuberculosis. Experimentally, it has been possible to produce foetal tuberculosis in pregnant animals rendered artificially tubercular. It has also been shown by experiments that the apparently healthy semen of tubercular animals will produce the disease when inoculated into animals. BANG of Denmark tells that a veterinary surgeon of his country traced the history of 24 Calves born from tuberculous cattle and made the following observations namely:-

10 were killed during the first week of life and presence of tubercles demonstrated. five were killed in sixth week of life and although to all/

all appearance perfectly healthy were found to be tuberculous. 6 others were killed at the same age as the last five in which tuberculosis had been diagnosed during life, and 3 became tubercular after having been pregnant once. Tuberculosis of children may be therefore congenital. KEATING³ observed that a tuberculous mother can transmit the disease to her offspring in utero and that bacilli and their spores can be conveyed by means of seminal secretion to women when no apparent tubercular disease is present in the male generative organs. That it is not possible to transmit the disease directly to the foetus the mother not proving a fertile soil, and asks if so is it not possible for the inheritance to become latent in the child, only to manifest itself when accident or environment tends to bring it into activity, and thinks it possible to go further and assert that the bacillus or its spores inherited from either parent may be carried into another generation, and either become manifest in glandular affections, joint troubles, or even finally in pulmonary disease. Other authorities again assert that fully 50 per cent of phthisis cases show the taint in their family record and say that although contagionists believe that the susceptibility only is inherited they feel convinced that tuberculosis like syphilis often gets more than susceptibility from its progenitors.

Hereditary predisposition. Some authors believe that ~~about~~ about 45% of phthisis cases have a strong family predisposition to the disease. Gairdner says that the hereditary proclivity to tubercle in certain families is notorious, and that Metchnikoff's theories would tend to prove that some have defensive processes to withstand the invasion of the tubercle bacillus. He remarks that there are catarrhs, ^{and catarrhs} some people/

people suffering from catarrhs from infancy onwards but never developing phthisis, whereas in other people a single attack of catarrh is followed by phthisis, thus shewing individual differences in susceptibility to the disease. Kanthack⁴ says " The least impartial must confess that tuberculosis is certainly not contagious for all men alike but broadly speaking only to those who as we express it have a predisposition towards the disease. We know of men who for years have exposed themselves to the danger of infection, have inhaled the tubercle bacilli, have wounded themselves with tubercular matter and yet never acquired the disease. This is a fact which is almost universally acknowledged. Tuberculosis is contagious under special conditions only a special predisposition is acquired unless it has been inherited."

Havilland Hall again remarks " This so called hereditary predisposition to consumption is in reality nothing more or less than a question of environment and proximity to the risks of personal infection. "

Infectiousness of Phthisis. As we have already seen Villemin and others

recognised the infectious nature of phthisis

long before the discovery of the tubercle bacillus by Koch, The recognition therefore of its dependence on the tubercle bacillus of Koch brings the disease under the category of an infectious and therefore preventable disease.

MORGAGNI in the 17th Century stated that it was customary in Italy to burn the bedding of people who had died from phthisis, and mentions that he was unable to tell much about the post-mortem appearances of phthisis, as knowing its contagiousness, he always avoided if possible opening and examining the bodies of the victims of this disease.

In/

In Italy and the South of France there still exist old copies of edicts confining those who " spat up their lungs" to certain places (Brouardel, Ruffer.) In the Western Highlands of Scotland consumption was considered infectious and sleeping in the same bed or wearing the same clothes as consumptives was avoided. RUSSELL⁵ also records this fact.

R. Shingleton Smith remarks that the clinical evidence of contagion has always been weaker than the experimental and that consequently medical men have only reluctantly accepted the idea that phthisis should be classed amongst the diseases which are undoubtedly and demonstrably contagious, and Koch⁶ points out " The fact that tuberculosis is a preventable disease ought to have become clear as soon as the tubercle bacillus was discovered and the properties of this parasite and the manner of its transmission became known." The evidence adduced would tend to show that all these views are correct, but there are different ways of interpreting some of them. For instance inherited susceptibility may be often explained as Havilland Hall says by environment, and is in reality an acquired susceptibility ^{and not an inherited susceptibility} at all. Similarly Gairdner's view that some people may take catarrhs repeatedly without developing phthisis, whereas in other people a single attack of catarrh is followed by phthisis, may be explained by the fact that in the former case the persons have never been brought into contact with the tubercle bacillus, whereas in the second case they have. My experience of phthisis in the West Highlands of Scotland during the past 10 years led me early to regard the influences of heredity and susceptibility in the disease as of very minor importance and to look upon the disease as a purely infectious one, and subsequent investigation into the cause of phthisis in the district mentioned has tended all along to/

to strengthen this view. Indeed I may say that I have never come across a single case of what ~~one~~ would regard as direct hereditary consumption, nor in any of my cases could I even say that there was an inherited susceptibility. That this view was the outcome of personal observation and investigation may be inferred when I state that when I graduated in medicine in 1893 I firmly believed in a "tubercular diathesis."

The first case that aroused my attention to the purely infectious nature of the disease was that of a medical man, a native of Skye, who practised in a large English manufacturing town where he contracted phthisis, and returning home to his native island died of the disease. Before his illness a more perfect specimen of virile manhood it would be impossible to imagine. He belonged to a family in whom not the slightest suspicion of phthisis or tubercular taint was present for generations back. This single case points to two things namely that phthisis is an infectious disease and that it is in the first instance an imported disease in the Highland rural districts.

The inhabitants of the Western Highlands and islands until within recent years enjoyed immunity from phthisis in a much greater degree than in other parts of Scotland. Various reasons have been brought forward at different times to explain the cause of this immunity. MORGAN⁷ attributed to the inhalation of peat smoke a protective influence on the lungs preventing tubercular disease, while others attributed the non-prevalence of phthisis to the influence of the gulf stream rendering the climate milder and more equitable and better adapted to chest complaints.

The/

The exposure of the inhabitants to the hardening influence of the weather was also cited as a cause of immunity by some. The food of the people consisting of meal, milk, fish, and potatoes was supposed also to ward off consumption. The amount of ozone in the air was brought forward as another protective agent. McNAB⁸ writing in 1869 says that in a population of over 2500 he had not observed more than 5 cases of pulmonary consumption in a period of 9 years. His paper next contains a criticism of the different causes of immunity cited by other writers. McNab denies the protecting influences of peat smoke * and regards it more as an irritant likely to aggravate the disease, and remarks that the same immunity from consumption was enjoyed by those inhabitants who lived in slated houses, and burned coal as fuel. The action also of ozone he regarded as an irritant to the mucous membranes of the air passages and lungs. To the theory that the inhabitants of the Hebrides and north west coast of Scotland generally are less susceptible to disease in general and pulmonary consumption in particular than other nations he replies "When we draw a comparison between different places inhabited by a similar race of people and find that in one pulmonary consumption carries away one in ten of the entire population whereas in another it is almost unknown it cannot be held that "peculiarity of race" has any special relationship with the immunity from the disease. In Wales for instance where the history, the language, and the general manner and appearance of the people denote Celtic origin, pulmonary consumption is as prevalent probably more so than in any other part of the kingdom. The same holds good in the northern counties of Ireland which are known to be inhabited by a people purely Celtic. It is important to observe that/

* Galen points out the fact that phthisis was uncommon in places where turf was used as fuel.

that it is only at home or in his native country that the Celtic Highlander enjoys immunity from pulmonary tubercle ; when he emigrates or follows his trade or employment in other parts more especially in towns, he is by no means exempt from the disease. and in most of the cases met with in the Hebrides the disease will be found to have originated elsewhere and the patient either sent home to die, or to benefit by the pure air of his native shores" He then brings forward his own view of a local cause (which he says was hitherto unknown) of immunity due to the presence of marine algae and says " It occurred to me that there was some distinct relationship subsisting between the endemic absence of pulmonary consumption in the Hebrides and north west coast of Scotland, and the algal vegetation of these districts the disease being less prevalent where the algal vegetation is most abundant and finds its maximum development. The algae give out a large quantity of oxygen and combine in their tissues the carbonic acid exhaled by animals during the process of respiration or generated by the combustion and decay of vegetable matter. And seeing that in consequence of the vast fields of marine algae existing in the Hebrides, there is a perpetual source of oxygen - a substance so essential to animal life - and the well being of the economy it must exert some special salutary influence in that class of diseases, where there is deficient aeration of the blood; and when we consider that in the Hebrides and along the north west coast of Scotland a disease such as pulmonary consumption, which may be regarded as a typical representative of this class is as a general rule unknown, and that it is so prevalent in other places, where there is a vitiated or non-oxygenated atmosphere such as the factory, the mine, or the workshop, then we discover a distinct relationship between the highly oxygenated atmosphere and the endemic absence

of/

of the disease. * He admits as an auxiliary cause the frequency of intermarrying amongst the inhabitants and quotes the following from an address by Dr. Jenner to the Epidemiological Society of London in 1866 "That tuberculosis is transmitted from parent to child is one of the best established facts in medicine. The extreme frequency of tubercular diseases in some circumscribed country districts is in part at least explicable by the frequency of intermarriage amongst persons living in such districts: and conversely the exemption of particular circumscribed districts from tubercular disease is due to the same cause: in one case from some special circumstance tuberculosis has been introduced into the district, and then spread in it from the cause I have mentioned i.e. intermarrying. In the other case the freedom from the disease of the district at any given time is the cause of its continued freedom. Intermarriage of the inhabitants the disease being present spreads it far and wide: intermarriage of the inhabitants the disease being absent prevents ~~the~~ introduction."

I have purposely reviewed this paper of McNab's at some length, because, although the ultimate conclusions he draws are in the light of our present day knowledge of the infectious nature of the disease quite erroneous still his paper on the whole is rather interesting and instructive, and taken together with his quotation from Dr. Jenner's address has a certain amount of bearing upon what is to follow. The prevalence of phthisis in the West Highlands and islands has become rather notorious within recent years, and we cannot deny the fact that it is much more rife than it was say fifty years ago. The absence of the disease in the districts where algal vegetation flourished was due to the fact that the Kelp industry afforded work for the people, who were therefore able to remain at home and were consequently not exposed to the action of the tubercle bacillus.

years ago. Still it is not naturally a disease of the Highlander, and one never meets with it among inhabitants who have never left their native glens and straths unless the infection has been conveyed to them by persons suffering from the disease coming among them. In the past the fact of their being shut off so to speak from much communication with large towns accounted for the rarity of the disease in their midst. Now however matters have entirely changed. Owing to the land having been to a great extent taken from the people, they are no longer able to eke out an existence on the patches left to them, with the result that most of the children as they attain to manhood and womanhood have to seek a livelihood elsewhere: and as large towns offer the greatest inducements they gravitate to them to engage in whatever employment they can find. There they are at once subjected to an environment in every way opposite to that to which they have been naturally adapted, and the result is that they quickly acquire a susceptibility to lung disease. As an example take the case of a Highlander who has been reared in an atmosphere of pure air, and has lived an active life, practically out of doors since infancy, and has always had sufficient plain wholesome nourishing food. He goes to a large town obtains a situation where he is immediately shut off from active out door exercise, and has to breathe the unhealthy atmosphere of a crowded work room, and to live in a small unhealthy lodging, and possibly lacks sufficient nourishing food. He becomes weakened and his tissues become vulnerable and an easy prey to the ravages of the tubercle bacillus. He contracts phthisis and is unable to follow his employment. His means of subsistence are thus stopped and it only remains for him to seek a refuge under the paternal roof at home, with the expectation of being cured. Most likely he occupies the same room and bed with a brother at home. Instead of getting better he gets worse and dies.

The brother who has been his bed fellow remains possibly well for months, or perhaps a year or two, and then begins to show evidences of declining health with symptoms of consumption. Another member of the family is told off to look after him possibly in this case a sister who is unremitting in her attention. He then dies of the disease and his sister then takes ill in like manner and dies, and so this clinical picture goes on until a whole family is exterminated. In many cases members of the family who have escaped the ravages of the disease away from home are brought back to help in nursing, and fall a prey to the disease there. This is no exaggerated picture. I have seen six members of one family die in this way although no suspicion of phthisis could be detected in either parent or any of their ancestors. Again ~~an~~ intermarriage is so customary among the inhabitants this brings the different families into closer relationship with one another. In this way relatives volunteer to nurse the sick consumptives of other relations, and contract the disease, which they in their turn pass on to others, and so the disease spreads from one member of a community to another. The explanation given of all this is that consumption is hereditary, and the families in question have a "tubercular taint" in them, while the true explanation is as the above clinical picture shows - direct contagion from one member of a family to another.

Similarly female members of families may contract the disease in towns, return home and infect others, but not to the same extent as will be shewn ~~pat~~ later. From the researches of Koch we know that the bacilli may be found long before the actual formation of tubercle and this explains the interval that may elapse between each member of a family showing clinical signs of tubercle in the lungs. It is found that phthisis prevails more among the male than the female population of the Highlands. The following

figures taken from the "Detailed Annual Report of the Registrar General" show this especially in regard to the insular rural districts.

Proportion of deaths from phthisis to every 100,000 persons of the population allowing for causes not specified.

Principal Towns.

<u>Period</u>	<u>Both Sexes</u>	<u>Males</u>	<u>Females.</u>
1844 inclus.	267	269	275
1895 "	210	216	205
1902 "	165	187	160

Large Towns

	<u>Both Sexes</u>	<u>Males</u>	<u>Females</u>
1844 "	229	210	246
1895 "	186	174	196
1902 "	154	140	167

Small Towns

	<u>Both Sexes</u>	<u>Males</u>	<u>Females</u>
1844 "	201	185	217
1895 "	167	159	175
1902 "	131	132	131

Mainland Rural

	<u>Both Sexes</u>	<u>Males</u>	<u>Females</u>
1844 "	153	144	161
1895 "	137	134	140
1902 "	126	130	121

Insular Rural

	<u>Both Sexes</u>	<u>Males</u>	<u>Females.</u>
1880-4	172	187	159
1885-9	158	174	144
1900-2	173	196	154

Various explanations have been forthcoming to account for this fact among which may be mentioned that women being accustomed to live more indoor than men in the Highlands, take more kindly to and are better adapted to the changed environment of town life. The true explanation I think is that females when they migrate to towns are mostly engaged in domestic service. They are well fed and housed, and when they are ill they receive medical attention; should they develop phthisis, their employers often place them in hospitals or institutions for treatment where they either recover or die. The males on the other hand are often engaged in unhealthy occupations under insanitary conditions, their housing and food are inferior, and if illness overtakes them, they have not the means to procure proper medical treatment, and after struggling on ill at work as long as possible, they are forced to return home at last, most likely in an incurable condition, where they die. MCNEILL⁹ has drawn attention to some of these facts also.

I have pointed to the fact that Highlanders seem specially prone to contract phthisis when their environment is changed from the free life of the country to the confined life of the town, and have mentioned some of the causes tending to this susceptibility. From the investigation of a considerable number of cases arising among the inhabitants at home through infection from imported cases, I have been struck by the marked susceptibility in them also, although the conditions applying to those living in towns do not hold good in their case, and I have been forced to the conclusion that Highlanders either at home or abroad exhibit a degree of susceptibility to the disease which is difficult of explanation. Consanguinity in some cases might induce susceptibility

but into many of the cases no such factor enters. The study of immunity I think throws some light on the subject. Immunity may be defined as the power to resist infection. Metchnikoff believes that the leucocytes of the body attack the invading bacilli: while Ehrlich regards the body fluids as the protecting agents. The latter however admits that a bacterial toxin is only poisonous when in combination with a cell constituent. These theories of immunity have been developed greatly by Welch, Wright and many others. In the discussion on immunity at the British Medical Association Meeting at Oxford last year, Bulloch in an exhaustive review on the existing state of knowledge on this subject says "Thousands of facts point to the conclusion that our leucocytic forming tissues are our great defensive organs against parasitic invasions. The mystery is how the microbes are destroyed, and in this connection we seem pretty much in the same state as John Hunter was a century ago when he wrote of pus. The final intention of this secretion of matter, is, I believe, not yet understood. although almost every one thinks himself able to assign one, and various are the uses attributed to it." This utterance coming from such a high authority as Bulloch leaves the question of immunity open for further speculation. Although the experiments of workers in this field of research tend to elucidate what action the tissues, cells, or fluids of the body adopt to combat the invasions of pathogenic bacteria, the "vital element" is wanting in all such experiments. We can however from studying the views and experiments of these authorities suppose what happens when the bacillus of tubercle gains access to the lung tissues, and is to be expelled without causing any appreciable injury to such tissues. Simply and crudely we may say that when the bacilli effect a footing in this congenial soil through slight breaches of surface, they multiply and form toxins or poisons which are thrown into the blood. To combat this invasion the body must

exert itself and it does so by bringing forward an army of leucocytes or phagocytes to the seat of invasion. The phagocytes secrete substances antagonistic to the bacterial poisons, called antitoxins. The phagocytes attack the bacilli and devour them, and the antitoxins secreted by the phagocytes neutralise the toxins excreted by the bacilli. In this way the foe is annihilated and the patient escapes so to speak ~~scatheless~~.

Next let us suppose that ~~an~~ overwhelming number of the bacilli gain access to the tissues of the lungs at one time. Phagocytosis and antitoxin forming cannot be carried on at a sufficient rate to destroy all the bacilli and neutralise all their toxins, and as a result we have phthisis developing. We might assume that phagocytosis is a function of the body governed by some vital nerve centre. We may therefore suppose that what occurs is, that the bacilli keep on multiplying in the lung tissue and excreting toxins, and that the leucocytes or phagocytes keep on devouring as many of the bacilli as possible and neutralising as much toxin as possible. We have thus a continual contest going on for supremacy between the phagocytes and the bacilli. When the latter are prevailing we have the disease advancing with its well marked physical signs and constitutional symptoms. On the other hand when the phagocytes are prevailing we have an amelioration in the physical signs and constitutional symptoms owing to increased reinvigoration of the phagocytic nerve centre. Thus the struggle proceeds until either the bacilli are all destroyed and the patients disease effectually arrested: or until the patient succumbs to the tissue ~~and~~ changes and constitutional symptoms induced by the parasite and its toxins. This theory would explain how in given cases of phthisis we have the disease ameliorating in those whom we are able to place under conditions suitable to increase their vitality: in their case their

phagocytic centres are also reinvigorated and their phagocytic powers consequently increased: whereas in those in whom these conditions are unfavourable the reverse is the result. We know that in certain diseases such as the acute specific fevers one attack confers permanent immunity on the individual from future attacks, and we infer that the pabulum on which the bacilli fed inside the body become exhausted, and that if the body should be attacked in future by these bacilli there being no suitable soil for them on which to live and multiply they simply die from starvation as they are introduced. We have seen that the tubercle bacilli may be in the body without any physical signs of their existence being present, and we also know that evidences of healed phthisis are often found post mortem in subjects who have never complained during life of symptoms of phthisis. In the Morgue in Paris BROUARDEL found ~~that~~ in half of the necropsies on persons who had met with their death by accident (if such persons lived for about 10 years in Paris) evidence of healed tuberculosis either in the form of cretaceous transformation or fibrous cicatrization. In the Pathological department of the Glasgow Western Infirmary 20% of the bodies examined after death showed evidences of healed phthisis, although the history of these cases showed no evidence of their suffering from the disease during life.

Recognising these two facts I think we can safely infer that people are often attacked by the bacilli of tubercle, which their phagocytes are able to dispose of in the manner mentioned, and that for all the evidence we have to the contrary any common feverish cold may be the expression of this successful war of the phagocytes against the invasion of the tubercle bacilli: and it is quite reasonable to think that those people who have been able to withstand these slight invasions after a time acquire as it were an inoculation, ^{an immunity} expressed in a resisting power

to the action of the bacilli of tubercle, and that the cause of the diminishing element in pulmonary tuberculosis in large towns, where almost every member of the population must at some time or another during life be subject to attacks from the parasite, may be to some extent accounted for by this inoculation immunity giving rise to a resisting power; as well as by improved hygienic and other measures: and that in "every case the evolution of this resisting power has been due to the weeding out of the unfit, to the constant and prolonged elimination by the disease of individuals weak against it", and that this resisting power acting through generations now induces immunity in a vast number of those exposed to the infection enabling them to escape altogether, or producing the disease in such a mild type as to be entirely overlooked. I often wonder if the sputum of everyone suffering from ordinary feverish colds was examined, in how many cases the tubercle bacillus could be found. In this connection I might cite measles which in this country through inoculation immunity has evolved into an extremely mild disease, whereas in countries where the disease is unknown it decimates the population more than small pox does the unvaccinated. As an example one might cite the fatality from measles among the inhabitants of the Fiji Islands. Again the natives of malarious districts abroad, are practically immune to malarial fever, no doubt also explainable on this theory. Dr. James Ritchie in opening the discussion on Immunity at the Oxford Meeting of the British Medical Association last year remarked "The only other view which might be put forward is that the qualities to which immunity is due have come from the survival of the most immune." Now the difference in susceptibility between a population who we might say are thus inured to the action of the tubercle bacillus and one that is not must be very marked, and is explainable on the theory of inoculation immunity mentioned, and accounts for the difference in the power of

of resisting infection in the individual members of the population.

With regard to Highlanders we have seen that they enjoyed an immunity from phthisis in their own country before coming into contact with the population of towns, and we may infer that inoculation immunity played a very minor part in them in the past, and that consequently they have not inherited that power to resist the attacks of the tubercle bacilli that the inhabitants of towns have inherited, and that what has been called a hereditary susceptibility to phthisis in their case is really not such, but rather a lack of inheriting inoculation immunity. The same reason accounts for the extreme susceptibility of the natives of Australia and New Zealand, and the Kaffirs of South Africa to consumption, when they are brought into contact with the tubercle bacillus. We can quite readily imagine also that the phagocytes of those who are liable to the action of bacterial inhalation should be more active than those who are not, and that therefore persons living in towns have their phagocytic powers more developed than persons living in the country, because their phagocytes are constantly called upon to combat bacteria, which abound in the air they breathe, whereas those living in the country do not make the same demands on their phagocytic powers, as they breathe practically a germ free atmosphere, and their phagocytes are in consequence not so prepared or alert to resist the attacks of bacteria. It has often struck me that this reason accounts for the immunity seen among doctors and nurses against infectious diseases; the mortality from these diseases being small among them in proportion to the general public, although they are much more exposed to infection than the rest of the population. It would have been interesting to contrast the mortality from phthisis in the population of large towns, bred in the

the towns from generation to generation, and the floating or gregarious population of such towns, but I have been unable to find data on this point. ALFRED HILLIER^{10a} says " Of those exposed to infection for brief periods only a very small minority are infected. Of those exposed for days, weeks, even months in a small confined atmosphere many escape. Why many escape and others do not escape has not yet been scientifically demonstrated. But this we know that be the causes of apparent immunity what they may no person can develop tuberculosis who is not exposed to the possibility of invasion by the tubercle bacillus."

In the Med. Chronicle (Oct. 1895) Treves says " It is evident that the soil is of much more importance than the seed - that there must be a large proportion of a population who are practically non inoc^ulable while there is a proportion whose bodies form a suitable medium in which the bacillus can grow. Tuberculous disease may be acquired but it cannot be inherited."

The tubercle bacillus is the essential agent of infection in phthisis, and exists as a micro-organism in the form of minute rods about 2/3rds the diameter of a red blood/corpuscle in length, and contains rounded bodies which are regarded as spores. It grows slowly and only at a temperature approaching that of the human body. The bacilli and especially their spores are very resistant and retain their vitality for a long time. When placed in water at a temperature between 8° and 12° C. it resists for 52 to 70 days but after that period loses its virulence. It remains however virulent for at least two or three weeks. It resists intense cold for 20 to 30 days. Putrefaction does not appear to kill the virus and it has been found possible to reproduce the disease with pieces of lung which have been buried for over 160 days. In dried sputa bacilli have been found virulent after/

after six weeks of more, but are killed by being heated up to 70°C. for half an hour. It does not ordinarily multiply outside of the body. Sunlight kills it. These facts point to the extreme tenacity of life shown by the bacillus.

The infection of phthisis is communicated though the inhalation of the dust of dried expectoration of consumptive persons, which teems with the bacilli, or through inhaling the bacilli directly into the lungs from the fragments of fresh sputum coughed into the air by consumptives when brought into immediate contact with a consumptive patient.

KOCH¹¹ proved the highly infective nature of sprayed tubercle bacilli. A very roomy box having on one side an opening for the orifice of the spray apparatus, was placed in a garden at a good distance from any habitation. The spray apparatus was placed outside the box with its orifice projecting into the interior. The apparatus was connected by means of elastic tubing and a suitable length of lead pipe which passed through the wood work of a closed window with the indiarubber bellows and so could be worked from the room beyond the region of the spray. Pure culture from a phthisical lung in the human subject, No. 1 (carried through 23 generations in 15 months) rubbed up with distilled water and the fluid diluted to such an extent that it looked almost clear. Any visible fragments ~~present~~ present in the fluid subsided after standing a short time: the upper layer which showed hardly any opacity was poured off and used for inhalation - 50 c cm were dispersed in the course of half an hour on 3 successive days and inhaled by the animals in the box as follows - 8 rabbits, 10 guinea pigs, 4 rats and 4 mice. After the inhalation the animals were kept in separate roomy

roomy cages and well looked after. In some of the animals dyspnoea appeared after 10 days and 3 rabbits and 4 guinea pigs died in the course of 14 to 25 days. All the remaining animals were killed 28 days after the last inhalation. All the rabbits and guinea pigs had numerous tubercles in the lungs, the size of the tubercles being proportionate to the length of time the animals had lived after inhalation. There can likewise be no doubt as to the manner in which the tuberculous virus is carried from phthisical to healthy subjects. By the force of the patients cough particles of tenacious sputum are dislodged discharged into the air, and so scattered to some extent. Now numerous experiments have shown that the inhalation of scattered particles of phthisical sputum causes tuberculosis with absolute certainty not only in animals easily susceptible to the disease but in those also which have much more power of resisting it. It is not to be supposed that man would be an exception to this rule, but on the contrary we may surmise that any healthy person brought into immediate contact with a phthisical patient and inhaling the fragments of fresh sputum discharged into the air may be thereby infected. But probably infection will not often take place in this way because the particles of sputum are not small enough to remain suspended in the air for any length of time. Dried sputum on the contrary is much more likely to cause infection, as owing to the negligence with which the expectoration of phthisical patients is treated, ^{it} and must evidently enter into the atmosphere in considerable quantity. The sputum is not only ejected directly on the floor, there ~~to~~ dry up, to be pulverized, and to rise again in the form of dust, but a good deal of it dries on bed linen, articles of clothing, and especially pocket handkerchiefs - which even the

cleanliest of patients cannot help soiling with the dangerous infective material when wiping the mouth after expectoration, and also is subsequently scattered as dust." Koch then looked upon the dried sputum as the most fruitful source of infection but modified his views later as we shall see.

Tappeiner lost a servant who after carelessly handling the apparatus for spraying tuberculous sputum was attacked with an acute onset of pulmonary tuberculosis and died. THAON while experimenting on the effect of tuberculous dust upon animals himself fell a victim to it and was seized with an attack of tuberculous broncho-pneumonia which proved rapidly fatal. Tappeiner Weichselbaum and Veraguth all obtained positive results with spray experiments. Ransom discovered by microscopic

examination the presence of tubercle bacilli in the expired air of advanced phthisical cases, the vapour of which had been condensed by a freezing mixture. Williams detected a certain number of ^{^ tubercle} bacilli in the air of the wards of Brompton Hospital.

FLUGGE¹² assisted by Sticker Heymann, Laschtschenko, and Beninde who worked in his laboratory at Breslau, published a summary of a series of experiments on the infectivity of phthisis (1) through the inhalation of powdered dessicated tuberculous sputa (2) through the speaking or similar breath movements of a consumptive patient. Sticker secured infection in animals by inhalation of tuberculous dust when he rubbed fully dried sputum on a rag or board and blew with powerful puffs and freed the visibly dust laden air into a confined inhalation space, but did not if he lowered the strength of the current of air. CORNET produced tuberculosis by blowing the infected dust with a pair of/

of bellows into the mouths of the animals experimented on. Laschtschenko made phthisical patients cough upon object glasses and found that in some cases he could demonstrate the presence of the tubercle bacillus on the glasses. Flugge out of 25 guinea pigs coughed at in a repeatedly disinfected room by phthisical patients whose clothes were previously disinfected at distances from 20 to 25 c.m. for 3 hours every other day, 6 died showing symptoms of inhalation tuberculosis. Of these 2 died in 4 weeks and 2 in 7 weeks, 1 in 2 months, and 1 in 4 months, and he states that "through living together with coughing and drop disseminating phthisical subjects, if frequent proximity to the cougher up to less than 1 metre occur" infection will take place, and says that in his opinion these minute drops sprayed forth by the cough of consumptive patients have been shown as fully as demonstration without actual experiment on man, to be a most fruitful source of the infection of phthisis: and attributes in a much less degree to the inhalation of tuberculous dust a certain amount of infection. In 1901 Flugge states that further experiments by Frankel, Weissmayr, Englemann, Moller and others have confirmed and strengthened his views, and led Koch to regard and this mode of infection to be a more potent and virulent factor in spreading the disease than dried and pulverised sputa.

I have investigated 248 deaths from phthisis pulmonalis in rural districts in the west Highlands of Scotland, which I have classified in the following manner:-

1. Imported cases.
2. Cases arising at home from inhalation of tubercular dust.
3. Cases arising at home from inhalation of tubercular matter of phthisical patients directly into the inspiration current of healthy persons.

4. Cases arising at home in healthy persons occupying disinfected houses, in which persons suffering from consumption have died, and
4. Cases arising at home in persons wearing the clothes of - or sleeping in the bed clothes of - those who have died from consumption.

The first group consisted of 141 cases occurring in young adults males and females born of healthy Highland parents in whom no suspicion of a so called "tubercular diathesis" existed and who had left home through the force of circumstances to seek their livelihood principally in large towns and returned home suffering from the disease and died. All these cases depicted clinical narratives like the following examples: - M.A.M. a girl, left home in good health to finish her education in the town of E. She developed phthisis while there, and returning home in an advanced stage of the disease, died. D.M. a healthy male adult left home in perfect health to engage in work in a large town where he contracted phthisis. He persevered at work until forced by illness to give up. He then returned home in an incurable condition and died. I might enumerate other cases, but as all present similar features the instances quoted will suffice to show how phthisis is imported into the West Highland Rural districts.

In the second group there were 48 cases arising in healthy males and females at home through inhaling dust impregnated with tubercle bacilli from the dried sputum of consumptive relatives living in the same houses. As examples of this class let me quote the following :- I.M. a healthy boy contracted phthisis through living in the same house with his aunt who was suffering from the disease from which she subsequently died. The nephew spent a great deal of his time in his sick aunt's room, became infected, and died sometime after his aunt. Many cases might be adduced/

adduced of brothers contracting the disease from sisters ~~and~~ vice versa. In 3 of the cases the deaths occurred in persons not relatives lodging in houses where one or more members of the family suffered from phthisis. In one family, that of a gamekeeper, several members contracted phthisis one after another and died. In the house occupied by this family the floors were covered with deer skins on to which those suffering from the disease expectorated freely, and when the expectoration dried I have no doubt the virus in the form of dust particles containing the bacilli floating in the air accounted for ^{the} spread of the disease to the different members of the family as several were affected at the same time. In this group I have placed the cases where the infection spread from the sick to the healthy in the manner mentioned, as there was no evidence of members of this group sleeping with one another.

I have placed in Group III. cases where undoubted evidence existed of healthy members of families contracting the disease through sleeping with brothers or sisters or relatives already suffering from phthisis. and cases where husbands infected wives or vice versa. This group consisted of 41 cases. As instances I may quote the following:-

K.M. returned home suffering from phthisis which he contracted in a large English town. He married a healthy woman and after a year of married life died. His widow then began to show signs of phthisis which developed and she died within a year after her husband. D.S. slept with a brother who returned from the town of G. suffering from phthisis from which he died. Six months afterwards D.S. shewed well marked signs of acute pulmonary tuberculosis to which he rapidly succumbed.

In another case a girl returned home from the town of G. suffering from phthisis and died. She infected two sisters at home who slept with her and they died.

In this family were also 3 brothers and the father and mother. The two elder brothers slept in an out house, and remained uninfected. The father and mother and youngest brother slept in the kitchen and also remained free from the disease. Another case may be cited in this connection. A healthy Highlander married a lowland woman suffering from consumption who died shortly after marriage. He married a second time a healthy Highland woman and then he died from phthisis. His widow died a year afterwards from the same disease. A more marked proof of the direct infection in phthisis than the above it would be difficult to bring forward.

The fourth group comprised seven cases in which the disease must have been contracted in houses previously occupied by persons suffering from Consumption. As an example I may mention the case of a house which came under my notice some years ago. Three families one after another occupying it had members dying from phthisis. When brought under my notice I condemned the house. The roof was then taken off and the house gutted and the walls exposed to the action of the weather for a year. It was then re-roofed and inhabited again, and no case of consumption has occurred in it since, although more than five years have elapsed since then, and more than one family has occupied the house during that period of time.

In the last group of cases numbering 7, the victims contracted the disease through wearing the apparel or sleeping in the bed clothes of persons who died from consumption.

Without thoroughly investigating the links in the chain of infection in these cases one might be easily persuaded to believe that heredity/

and hereditary predisposition were the determining agents in these cases especially in members of groups 2 and 3, occurring as they do in different members of the same families, but closer study of the clinical evidence discloses the purely infectious nature of the disease, and substantiates what I have said in a former part of this paper as to the mode of introduction and spread of phthisis in the West Highland rural districts . The cases in groups 2, 3, 4, & 5 are in the first instance the result of infection from group 1, and would have been prevented altogether had members of the first group been isolated as they were imported. Another point that has to be taken into consideration is that there are numbers of persons now living and spreading the disease in the country who have been infected from these cases.

That phthisis is curable in the early stage no one will deny and there are few practitioners who have not experienced this gratifying truth in many of their cases, but when the disease is advanced, the chances of cure or permanent arrest are well nigh hopeless and the drug treatment of the disease has been proved to have very little effect in curing it. The only agents likely to influence the disease at all beneficially would be substances that increase the vitality of the phagocytic cells.

CULLEN wrote " We know of no medicines that can exert their specific effects upon the lungs by dissolving tubercular concretions; nor is it probable from what we know of the animal economy, that any such will ever be discovered." More than a century has elapsed since Cullen expressed this opinion, and although in the interval thousands of drugs have been advocated and used in the treatment of phthisis, so far as efficiency in this method/

method of treatment is concerned, Cullen's statement holds true at the present day.

Phthisis therefore being a disease for which no specific successful drug treatment has hitherto been forthcoming; a disease that is practically incurable in the advanced stages, and a disease that has been abundantly proved to be highly infectious the only rational way of treating it is by preventive measures. Let us suppose at the present time no treatment at all was to be adopted for all the cases of the disease that exist in the country, but that we could prevent these cases infecting healthy persons, the disease would become extinct in a generation or two. We know that the disease is not so infectious in its early stages and the indication therefore seems to be to try and cure those persons in the early stage of the disease and to prevent persons suffering from advanced phthisis infecting healthy persons.

Although a great deal of what has been done and is being done to prevent consumption in large towns everywhere does not apply to Rural districts of the West Highlands of Scotland, yet one is not in a position to express an opinion as to the most efficient measures to be adopted in trying to suppress the disease without first considering the ways and means used in large centres to diminish the mortality from phthisis, and as Glasgow is one of the principal breeding centres of this disease among West Highlanders we may first consider the methods that have been found most efficient in reducing the death-rate from phthisis there. The late Dr. Russell in the paper already quoted from points out that by the influence of general hygienic measures the death-rate from/

phthisis from 1860 to 1894 had been reduced 44 per cent without special treatment as an infectious disease and that in the twelve years 1883-94 dividing them into periods of six years the death rate fell 19 per cent a result he says much greater than the improvement in Prussia and Saxony which Cornet put to the credit of special prophylaxis, and Russell advocated the supreme importance both for the profession and the public to lay in their minds a broad foundation of positive knowledge as to the nature of tuberculosis; the necessity for thorough disinfection after every death from phthisis; instruction by dissemination of popular leaflets, as to the nature of the disease and the methods of preventing it; the suppression of dark and damp dwellings, and the free admission of light and air in and around tenements, workshops, warehouses, counting houses, or offices; provision of open spaces and play grounds near tenements; suppression of smoke and overcrowding, and spitting; and instruction to householders as to best ways of dealing with domestic dust. These hygienic measures have been further developed by the present Medical Officer of Health Dr. Chalmers, but he says that in regard to bacteriological examination of sputa and voluntary notification which have been introduced their experience had been disappointing. They had had ample use taken of the facilities offered from the well to do residential districts, but had almost total absence of use made of these facilities in the lower class districts. Voluntary notification had left them with the impression and the with unhappy conviction that they were presently missing two-thirds of the cases occurring in the worst districts for want of notification, and that it was in these poor houses that the spray infection was most deadly.

In New York in 1886 the City Board of Health under the guidance of Dr S Biggs and Huddleston adopted rules for the sanitary supervision of persons affected with tuberculosis such as notification, inspection in certain cases of tenement houses, hotels, and boarding houses: compulsory disinfection of tuberculosis infected houses, or clothes, after death or removal of patient: the bacteriological examination and diagnosis of cases more especially in early stages: the education of the people as to the infectious nature of tuberculosis by means of hand bills and circulars: isolation in hospitals and Sanatoria. The influence of these measures was to reduce the mortality from tuberculosis by more than 35% . Notification has also been adopted in Saxony and Norway with marked success. Voluntary notification has been adopted in several English towns. In Prussia what has been achieved by prophylaxis from the recognition of the danger of infection and the consequent greater caution in intercourse with consumptives is shown by Cornet's calculations regarding the decrease of mortality from tuberculosis in Prussia in the years 1889 to 1897. Before 1889 the average was 31.4 per 10000 whereas in the period named it sank to 21.8 per 10000.

In England the death rate from phthisis has been declining since 1838 when it was 38 per 10000 till the present time when it is 13 per 10000 and is attributable to generally improved sanitary conditions and food standards among the working classes, and Koch attributes this also to the fact that England possesses a considerable number of special hospitals for tubercular patients and says " there can be no doubt that the diminution of tuberculosis in England which is much greater than in any other country is greatly due to this circumstance." HILLIER¹³ draws attention/

attention to the fact that from 1876 to 1886 when our tuberculosis death rate was steadily diminishing the Prussian rate remained stationary at about 31 per 10000. But in 1887 the drop in the Prussian rate began and has continued down to 1900 when it had fallen to 21 per 10,000. In England in the same period the drop in the tuberculosis death-rate has only been from 24 to 19 per 10,000, and he attributed the more rapid fall in the Prussian death-rate since 1887 to the discovery of the tubercle bacillus, and the spreading of the knowledge of the infectious character of phthisis, which Koch asserts has led to the taking of precautions even among the lowest classes in Germany, and to the greatly improved general conditions of the working classes brought about by the operation of the Workmen's State Insurance Laws, the first of which ^{the} Sick Insurance Law came into existence in 1883, and to the establishment of sanatoria in a less degree. In Germany there are hundreds of Sanatoria maintained by Insurance Societies who find that it pays them to cure their subscribers rather than pay the claims which they would have to meet were the disease allowed to run its course.

As long as phthisis exists in the large towns so long will it prevail in the West Highland rural Districts, for towns act as breeding centres where Highlanders contract the disease and returning home infect others in the manner already pointed out. It being therefore impossible to exclude cases of pulmonary consumption from these districts the problem comes to be one of safe guarding the resident population from being infected by imported cases. The first thing that will tend to lessen the spread of the disease will be the recognition by the people of its purely infectious character. We have ~~the~~ seen that in Prussia such recognition and the consequent/

consequent greater caution in intercourse with consumptives has been the chief factor in diminishing the mortality from phthisis. We must therefore instil the supreme importance of this fact into the minds of the people. As long however as the people are taught to regard the disease as hereditary and not infectious they will make no effort to protect themselves from it and consequently there can be no headway made in stamping it out. Were they fully cognisant of its highly infectious nature one would not long find such evidence of its ravages. The death rate from phthisis has been gradually diminishing in the towns from various active measures adopted in combating the disease, but in the Rural and Insular Rural districts the mortality has not been diminishing relatively as will be seen from the following figures calculated from the "Detailed Annual Report of the Registrar General":-

Proportion of deaths from phthisis to every one thousand persons of the population allowing for causes not specified:-

Year	Principal towns	Large towns	Small towns	- Main. Rural.	Insular Rural.
1882 incl.	2.7	2.5	2.1	1.5	1.7
1884	2.6	2.2	2.0	1.5	1.7
1893	2.1	1.8	1.6	1.3	1.5
1902	1.6	1.5	1.3	1.2	1.7

These figures show that the mortality from phthisis in the mainland rural districts hardly shows any diminution in 24 years, and that in the insular rural districts there is absolutely no diminution whereas in all the towns the diminution is very considerable. Again taking the phthisis death rate per 1000 of the population for the county of Argyll from the Annual Reports of the County Medical Officer of Health we find that in

v	1891 - 3 incl.	it was	1.071.
	1894 - 6 "	" "	1.250
	1897 - 9 "	" "	1.055
	1900 - 2 "	" "	1.017
	1903 - 4 "	" "	1.129

an increase rather than a diminution in the death rate.

Looking to the infectious nature of phthisis we would expect an increase rather than a diminution in the death rate in the rural districts of the West Highlands, because communication is being opened up more and more between the towns and the country and a greater proportion of the rural population migrate to the towns, and therefore a larger number of these contract the disease which they import into the country in the manner stated, and consequently we have more of the native population also infected. We may therefore rationally assume that unless measures are adopted to prevent the propagation of the disease in the rural districts by the time the disease becomes extinct in the towns it will still flourish in these country districts and they in their turn will become breeding areas for the towns.

This danger shows that no district or community can afford to neglect taking measures to prevent the spread of the disease.

As the spread of phthisis in the West Highland Rural districts is due to the infection of the resident population from imported cases of the disease the most effective way of stamping out the disease would be by isolating cases of the disease as they are introduced. This could only be done by having Sanatoria in the various districts for the treatment of these cases. It has been amply proved that the climate of Britain is just as suitable as that of any other country for carrying out the open air treatment of the disease. A great deal has been written in the medical Journals recently as to whether this method of treatment is worth while.

Personally the results I have seen in cases I have sent to Sanatoria for the past number of years have been more than gratifying. Even in cases where only slight improvement has taken place during a patient's sojourn in these institutions the educative influence has been such as to make the sufferer anxious to continue the curative measures learned there, and thus he prevents himself becoming a focus of infection for others. The only drawback to Sanatorium treatment hitherto is the great expense of it. Sanatoria to be effective and cheap should be built on the hut system. There is no need for the huge expense at present expended on these institutions. What would be quite as effective would be numbers of small corrugated iron and wood cubicles erected at some distance from each other for the patients. This would insure the proper segregation of the cases, and prevent slight cases of the disease from being re-infected from advanced cases. A central pavilion with kitchen dining-hall and open verandah where patients could sit in wet weather would also be necessary. These cubicles could be built to a pattern so that districts could acquire them gradually as they were required for fresh cases. The Sanatoria should be built away from the sea as most of the inhabitants live on the sea coast and the change inland would be advantageous. I have found great benefit from removing patients in the early stages of the disease from the coast to inland Highlands. A southern exposure considerably above the sea level would be most desirable. The Glasgow and District Branch of the National Association for the prevention of Consumption have erected a small Sanatorium at Bellfield Lanark on cheaper lines than the expensive buildings at present ⁱⁿvogue in this country and the County of Ross have collected sufficient money for the erection of a small County Sanatorium for the more advanced cases of the disease.

Were other Counties in the north west of Scotland to start similar public subscriptions there are many wealthy and philanthropic people connected with these counties who if approached would be prepared to bear the initial cost of erecting sanatoria on the lines mentioned for the benefit of the poor. County Councils should then be empowered to administer these Institutions out of the public rates. The extra expense entailed would soon be more than counterbalanced by the saving in the poor rates. The mortality from consumption alone in our rural districts is more than treble that of all the other infectious diseases added together, and the amount of public money spent on the latter is very considerable, and from an economic point of view this public expenditure is not so justifiable as it would be were it spent in the treatment of consumptives. The care of the insane is also a great drain on public resources and the ultimate benefit to be derived from it is as nothing compared to what would be derived from the same expenditure in the prevention and treatment of consumption. While hygienic measures of all kinds as carried out in towns will tend greatly to lessen the spread of phthisis in the West Highland rural districts its complete extinction can only be looked for by isolating the cases of the disease as they are imported, and this can only be effected by means of Sanatoria.

The question of the relationship or identity of human and bovine tuberculosis I have not touched upon as I shall have dealt with phthisis pulmonalis alone, but from the literature upon the subject we cannot help believing in the distinctness of the two diseases as pointed out by Koch¹⁴ and that in consequence little stress need be laid upon the consumption of the meat and milk of tuberculous cattle causing/

causing the disease in the human subject. The Royal Commission on Tuberculosis whose Report is to be issued shortly may throw more light on this interesting and important enquiry.

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