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Pulmonary Tuberculosis.

A Study

of

Recent Researches in Immunity

with special reference to

Pulmonary Tuberculosis.

Observations

of

Numerous Cases.

Suggestions

as to

Treatment and Prevention.

A thesis

presented to the

University of Edinburgh

for the

Degree of Doctor of Medicine. 1898.

by

James Scott M.B. O.M. 1894.

D.P.H. 1897

43 Minto St. Edinburgh.
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8. Suggestions as to Prevention. 203.
Preface

The following thesis is the result of four years study of pulmonary tuberculosis in its many different phases.

The subject of pulmonary tuberculosis, suggested itself to me as a suitable one for a thesis, during my term of eighteen months at the Victoria Dispensary for Consumption and Diseases of the Chest, Edinburgh, under the care of Dr. R. W. Philip. And while on for twelve months as Special Non-Resident Clinical Clerk in the Medical Waiting Room of the Royal Infirmary, Edinburgh. The cases I have seen in the wards of the Royal Infirmary, Edinburgh, and my own cases during four years of private practice.

These appointments afforded me exceptional opportunities for the study of pulmonary tuberculosis, of which I took every advantage.
Introduction

There is probably no disease of greater interest and importance to the general practitioner of medicine, than that of pulmonary tuberculosis. It confronts him on the very threshold of his career, and not uncommonly, he is then, although well educated in the science of medicine, not in a position to diagnose the disease in its earliest manifestations, as it often presents itself to him in general practice.

It is therefore a disease with which the practitioner should be well acquainted, especially in its earliest stages, when much can be done to arrest the further progress of the disease and in many cases bring about a cure. But pulmonary tuberculosis is so insidious in its onset, and so varied in its manifestations, that even the most careful and experienced physicians are sometimes at considerable difficulty in arriving at a correct diagnosis.

There is no disease in which,
Empiricism both in practice and theory has played a greater part than in pulmonary tuberculosis.

By the discovery of Koch, in 1882, of the Tubercle Bacillus, and its close relation to tuberculosis, a new impetus was given to the study of tuberculosis. And great advances have been made in Bacteriology, in the Prevention and Treatment of this malady. Since that date more has been learned of this disease than was learned in the two thousand years previously.

The vast amount of knowledge that has accumulated on this subject shows how much has been done towards the evolution of principles—preventive and therapeutic. And with all this knowledge, how much must yet be done to further advance these principles, and to entirely eradicate the disease, both human and animal.

It is especially to the Ctiology, the Prevention and the Treatment of pulmonary tuberculosis, that I dedicate
these pages. I am the hope, that however feeble the attempt may be, it may help to increase the sum of human happiness, by lessening the suffering and fatality of the disease.

I have to acknowledge my obligations to those who have so kindly assisted me in the study of this disease - to Dr. Robert Muir of the University of Edinburgh, R. I. C. Leith of the Royal Infirmary, Edinburgh; Professor R. Stockman, Glasgow University, and to many others. But I wish especially to express my gratitude to Dr. R. W. Philips.

N.B. The numbers throughout the thesis refer to the books named in the Bibliography, page 43.
History

The study of tuberculosis as a general disease, characterized by miliary eruptions in the different organs, is comparatively recent.

Hippocrates described it as a destructive ulceration of the lungs, and gave the symptoms and signs of an advanced case of phthisis pulmonum.

Bonnet, Sylvius Deleboe, Manget and others describe a disease which we today call tuberculosis.

Sylvius Deleboe described tubercles as the lymphatic glands rendered visible by the disease, which in the normal state were invisible.

In 1793, Baillie of England said that tubercle was a special production in the lungs of phthisical persons, and that the large tubercles were the result of an agglomeration of small tubercles. Bayle was the first to study tuberculosis on an anatomical basis, and classified phthisis into six kinds, based on the results of 109 autopsies of phthisis.

Laennec clearly established that pulmonary phthisis is a special lesion, and that the tuberculous matter developed in the lungs and other organs in two principal forms — miliary and granular.

The miliary tubercles he described as the most common. Their appearance as small grey grains, semi-transparent, sometimes transparent and colourless, and in consistence softer than that of cartilage. The larger ones vary in size between that of a millet seed and a hemp seed. At first sight they appear round, but on closer examination they seem angular.

The granular tubercles are larger in size than a millet seed, their form is exactly round or ovoid. They differ from the ordinary tubercles in the uniformity of their volume and colourless transparency. They are
generally disseminated throughout the whole extent of the lung. " These are the tubercular granulations of Bayle. But Länne regarding them as a special production — a kind of accidental cartilage — Louis (1825) was of the same opinion as Länne.

Brousseau was of the opinion that tubercle was the product of irritation and inflammation.

Crueilhier said that tubercle was a special inflammation of the pulmonary vesicles.

Undral agreed with Brousseau.

Towards the middle of this century we came to a new era in the study of tuberculoses, signalized by the introduction of microscopic observations by Liebert who was the first to study scrofula and tuberculoses microscopically and said they were two distinct diseases.

Reinhardt in 1847 said that tubercle could be formed from ordinary pus and, therefore, was non-specific. In 1850 he published his book in which
he stated that tubercle was simply an inflammatory product.

Virchow's opinion was that tubercle was a mode of termination of different processes of neoplastic nature—phlegmat-

—purulent—or catarhal; and for the term "Tuberculous matter" he preferred "Caseous matter". The result of a

special degeneration—an necrosis or necrobiosis of the cellular elements, which are transformed into small

round bodies more or less infiltrated with fatty particles.

Virchow and Laimee said it was even an special product—a tumour of small size. Again, Virchow said exsudation

was the usual, "but not the necessary

mode of termination of tubercle.

Bühler based his conception on 280 autopsies of tubercle, and declared that acute miliary tuberculosis was the

trouble of a preexisting caseous focus. He supposed that in the caseous centre there was elaborated a matter—specific and infectious
and could be disseminated by the blood, and cause tubercular granulation in other organs.”

Niemeyer was of the opinion that tuberculosis very rarely affected a lung which had not been previously affected with chronic pneumonia.

Villemin in 1865 discovered the inoculability and virulence of tuberculosis. Then follow the researches on the giant cell by Langhans, Hoster, Wagner and others. The significance and origin of the giant cell by Ziegler, Baumgarten, Cornil and others. The long controversies on the contagious and specific nature of tuberculosis (Klencke). The inoculability by Villemin. The production of tuberculosis by ingestion, inhalation, by Klebs, Gerlach, Starkhein and others. Also by inoculation (Marti).

In March 1882, Prof. Robert Koch communicated the result of his researches to the Physiological Society of Berlin on the Etiology of Tuberculosis. This great discovery established definitely and irrefutably the parasitic and bacterial
nature of the disease, and will for ever remain as one of the greatest triumphs in scientific medicine.

By the discovery of the Bacillus Tuberculosis, a new interest was created in tuberculosis, which has resulted in measures—preventive and therapeutic—being adopted which were formerly undreamed of.
6. **Tuberculosis**.

**Definition:**

"Tuberculosis is a chronic febrile disease, produced by the Bacillus Tuberculosis. It occurs as a natural disease in human beings and some of the domesticated animals, but as far as is known does not occur in wild animals. It is widely prevalent in the human race and in cattle. One seventh of mankind die of tuberculosis, and the prevalence in cattle may be stated as ranging from 10-20%" (Allbutt, Vol II).

**Specific Cause of Pulmonary Tuberculosis.**

The Tubercle Bacilli are recognised to be the specific cause of tuberculosis, and the presence of the bacilli in the sputum of patients is a distinctive sign of the existence of the disease. And the detection of the bacilli has consequently become a test which is constantly applied. It occurs in the sputum of phthisical patients in large numbers and is extremely virulent.
Immunity

By immunity is meant non-susceptibility to a given disease or to a given organism under certain conditions, and these conditions may be such as occur naturally, or may be experimentally produced. The term is also used in relation to toxins of an organism. Immunity may be possessed by an animal naturally, and is then called natural immunity, or it may be acquired by an animal, either by its passing through an attack of the disease occurring under ordinary conditions, or by artificial means of inoculations. We find for example that certain diseases affect the lower animals but never occur in the human subject, e.g. swine plague; and on the other hand, diseases such as typhoid and cholera, which are common in the case of human subjects, do not under natural conditions affect any of the lower animals, as far as is known. That is to say, man and the lower animals respectively enjoy immunity against certain diseases, when exposed to infection under ordinary conditions. Immunity may be of very varying degree,
and accordingly the use of the term has a corresponding relative significance.

Such a thing as absolute immunity is scarcely known, just as we have seen in cases of absolute susceptibility. This is not only true of infection by bacteria, but in the case of toxins also, when the resistance of an animal to these is of high degree. The resistance may be overcome by a very large dose of the toxic poison. This statement is well illustrated in the case of the great resistance to the toxins of tetanus possessed by the frog. This animal may be able to resist as much as 20 cc. of powerful toxin, but if this amount be exceeded may be affected by tetanic spasms. (Kämpfer). On the other hand, in cases where the natural power of resistance are very high, this can be still further exalted by artificial means, that is, the natural immunity may be artificially intensified.

In pneumonia, influenza, syphilis, experimental research has shown that in many of them a certain degree of immunity does follow, and though we cannot
state it as a universal law, it may be considered highly probable that an attack of an acute disease produced by an organism confers immunity for a longer or shorter time.

The corresponding general conclusions from experiments is that the more virulent the organisms injected, provided that the animal recovers satisfactorily, the higher is the degree of immunity acquired by it against that organism. Thus in developing immunity of the highest degree the most virulent organisms are employed. A corresponding principle, with certain restrictions obtains in the case of toxins.

In addition to these peculiarities in immunity or susceptibility, there are also individual differences in susceptibility or resistance to the action of pathogenic bacteria, which may be natural or acquired. As a rule young animals are more susceptible than older ones, i.e., age incidence.

Thus in man the young are especially susceptible to Scarlet Fever, Measles, Whooping Cough, and other "children's diseases." In tuberculosis the age incidence is
from 15-35 years, and after 40 years of age the susceptibility is very much diminished.

Considerable differences as to the power of resistance may exist among adults of the same species. In man these differences to infection are frequently manifested. If a number of persons be exposed to infection in the same way, some may escape entirely, while others have attacks differing in severity and duration. Similar results are met with in cases of accident, e.g., if a number of persons meet with similar accidents some may recover satisfactorily, while others have an attack of an infectious disease, e.g., erysipelas or tuberculosis.

There are examples of race immunity, e.g., the Negro is less susceptible to yellow fever than the White Race, and the mortality among the Whites is greater. A remarkable example of Race Immunity is that of Algerian sheep against Anthrax, a disease which is very fatal to other sheep.
At this stage the question naturally suggests itself. Upon what does this essential difference depend? Evidently upon conditions favourable or unfavourable to the development of the pathogenic germ; or upon its destruction by some active agent present in the tissues or fluids of the body of the immune animal, or upon a neutralisation of its toxic products by some substance present in the body of the animal which survives infection.

Before this question can be answered, we must have a clear idea of the modus operandi and modus intercipientis of pathogenic organisms.

Immunity is of two kinds (1) Active (2) Passive, and may be obtained by different methods.

1. Active immunity is obtained by:
   (a) Injections of the organisms either in an attenuated condition or in sublethal doses, or
   (b) Sublethal doses of their products i.e. toxins.

In this method a series of reactions are developed within the animal and this leads to immunity. Such methods can be preventive but can never be curative,
as the immunity must be developed before the onset of the disease."

C Passive immunity depends upon the fact that if an animal be immunised to a very high degree by the previous method, its serum has distinctly antagonistic or neutralising effects when injected into other animals along with organisms, or with their products as the case may be. Here the serum of the highly immunised animal may confer immunity on another animal, if introduced at the same time as infection occurs, or even a short time afterwards, and the method can therefore be applied as a curative agent. The serum is also preventive, i.e., protects an animal from subsequent infection, but the immunity thus conferred lasts a comparatively short time. These facts form the basis of serum therapies. To speak on serum the term Antitoxic was applied."

"In other diseases a similar method was afterwards employed by injecting
living organisms in gradually increasing doses, the serum of the animals thus immunised being effective in protecting another animal from infection from the organism. Such a serum is called Antiserum.

Community and Recovery from Disease. Recovery from an acute infectious disease shows that in natural conditions the virus may be exhausted after a time, the period of time varying in different diseases. How this is accomplished we do not yet fully know, but it has been found in the cases of Diphtheria, Typhoid, Cholera, Pneumonia etc., that in the course of the disease certain substances (called by the Germans Antikörper) are found to appear in the blood, which are antagonistic either to the toxine or to the vital activity of the organism. In these cases a process of natural immunisation would appear to be going on during the progress of the disease and when this immunisation has reached a certain height, the disease naturally comes to an end. It cannot, however, be said
at present, that such antagonistic substances are developed in all cases, so there are other means by which the spread and multiplication of the organisms may come to be arrested."

That some such antagonistic agent must be produced in the tissues of the body during the attack of a specific febrile infectious disease is evident when we consider the progress and termination of such diseases. If toxins alone were produced they would gradually accumulate in the body, and the patient would continue to suffer from their presence or die from an overdose of the poison. There would be no natural cure of the disease. But we know that some specific infectious diseases, in most cases, run a definite course, passing through certain stages and terminating in recovery or death, according as the conditions have been favourable or unfavourable to the patient.

In infectious diseases involving the system generally, a single attack may confer immunity from subsequent attacks.
This is true of the eruptive fever, typhoid, whooping cough. But it is not true of Influenza, Tuberculosis. Nor is it true of localized infectious diseases as Diphtheria. The immunity following upon such attacks, however, is not absolute, as second attacks of typhoid, small pox are known to have occurred occasionally. And from the fact that the immunity conferred, following upon an attack of the disease is not absolute, we learn that these diseases are curable and preventible under certain conditions favourable to the patient. The diseases in which one attack is not generally recognised as protecting from future attacks, it is probable that a certain degree of immunity of limited duration is acquired. This principle of immunity of limited duration, is true in cases of immunity artificially conferred by means of inoculations e.g. Vaccination against small pox is limited in its duration, and on that account re-vaccinations are advocated. Similarly with inoculations of Tuberculin against tuberculosis and Antitoxin against the venom of snakes. In Diphtheria, Influenza, Cholera, second attacks do not occur during the same epidemics.
The gradual production of such antagonistic substances may explain many of the phenomena during the attack of a disease e.g., the crisis in pneumonia, the wavy temperature line in tuberculosis, typhoid. Professor Bang, Copenhagen. In his work on the action of tuberculin in cattle as a diagnostic agent states that the further advanced the tuberculosis, the less the reaction to tuberculin. May this not be due to some antagonistic substance induced in the body of the cow by the tubercle bacilli?

That means of conferring immunity have been known empirically for generations is shown in the methods adopted by the natives of India before going snake hunting. They rub the venom of snakes into their bodies and by this means immunity is acquired; in other words, by the venom, antivenene is produced. It is also known that bee-keepers of long experience can be stung with impunity, whereas at the commencement of their experience each sting was followed by a reaction; and death has been known to occur from the sting of a bee.
The bee-keeper says he has got accustomed to the sting, but in scientific language he has been rendered immune by the repeated inoculations of the toxin of the bee. Another example is that of the dairy-maids being rendered immune against small-pox, as recognised by Jenner. These are examples of Empirical Knowledge and Latent Science.

No scientific explanation of these facts was given, till Pasteur demonstrated in 1880, that Chicken Cholera occurring in fowls was due to a specific micro-organism, and proved that a mild attack followed by immunity could be induced by inoculation with an "attenuated virus." Pasteur recognised the importance of this great discovery and applied it to many other diseases with satisfactory results.

e.g. Anthrax, Tetanus, Hydrophobia. 

"In Tuberculosis there is a natural immunity in some men and in some animals, but no animal has as yet been rendered immune to the disease; i.e. there is no means by which immunity can be.
Immunity to tuberculosis is only a relative term, because tuberculosis can be conveyed to animals by inoculation and feeding. It is a natural disease in man and cattle, rare in sheep, goats, etc. It is a disease, therefore, of men to live in houses, and cattle which are kept in stables from 10-20% of all cows are tubercular. In Copenhagen 17-7% of slaughtered cows and oxen were tubercular.

- Berlin 16-1% of slaughtered cows and oxen.
- Saxony 0.6% calves.
- Copenhagen 0.003‰ sheep 1890-93.
- Berlin 0.003‰ sheep 1892-93.

"Of all the domestic animals, therefore, Carnivora show the greatest resistance to the disease of tuberculosis experimentally." "It is evident from what has been said, that the question of immunity is as difficult of explanation in tuberculosis as it is in any other disease. In the present state of our knowledge, but little can be..."
said of the factors which constitute immunity or resistance to the invasion of an infective agent:—whether, on the one hand, this resistance resides solely in the formed elements of the body, or, on the other hand, in the liquids of the body, or both. It is not known in what way the resistance to tuberculosis may be increased, except in the vague sense of increasing the general health of the body. But in the human being there are undoubtedly many conditions which diminish the resistance to the invasion of tubercle.

alcohol, syphilis, diabetes, cancer, worry, certain trades as stone masons, printers, previous injury, climate, soil as damp and imperfectly drained subsoil, change of temperature, irregular or insufficient food, inherited weakness, overwork, insufficient outdoor exercise, life in close atmosphere, sedentary habits.

In many cases of specific infectious diseases as pneumonia, typhoid, when once started, run a course of their own and terminate in spontaneous cure.
according to the virulence of the organism and conditions favourable to the patient. In tuberculosis also there are many cases of spontaneous cure. This fact is well illustrated by the number of cases of Obsolete or Retrograde tuberculosis in the lungs, e.g.

In about 9% of all necropsies, Allbutt says 7 of all cases examined.
Fowler 25
Kehler (Berlin) 4

In the Report to the Board of Supervision on Tuberculosis (Bovine), 30th March 1888 Dr. (now Professor) Henry D. Littlejohn says, Bovine Tuberculosis is essentially a chronic disorder, and it may as in man, last for years before it proves fatal. It may also, as in man, undergo spontaneous cure. No fact is more remarkable than that there is no disease which is apparently so curable as phthisis. I hardly ever open the body of a person dying from an injury or disease, but traces of the previous existence of tubercle in the lungs are found. And it is apparent that this disease has
been arrested and a cure effected. Similar cases are seen in cattle, but more seldom, as in this country the animal is slaughtered for food before the process of cure can be completed."

Microorganisms are classified according as they are pathogenic or non-pathogenic. The pathogenic organisms are those which are very virulent to some species of animals, and less virulent to others e.g. anthrax bacilli. And recent investigations, both experimental and clinical, have shown that pathogenic organisms produce substances—toxins—which, when introduced into the body, give rise to reactions similar to the symptoms produced by an attack of the actual disease. Koch, Philip and others have demonstrated that the morbid changes manifested during an attack of tuberculosis are not due to the tubercle bacilli per se, but due to the action of their toxins. The symptoms produced by the subcutaneous injections of the filtered product
of tubercle bacilli. So mammals are.

"Contractions of pupil, great depression, action of heart slowed and stops in diastole, voluntary motor depression leg action evident on the higher centres, respirations rapid, fibrillary twitchings, weight decreases, appetite poor, vomiting, thirst." (Philip).

The fact that many of the symptoms of an infectious disease are due to the action of the toxins is well shown in the case of localized infectious diseases e.g. Diphtheria, where it may be said an auto-inoculation takes place from the organisms in the larynx. And from these facts we may infer that if the toxins be completely neutralized, the animal will have acquired immunity for a longer or shorter period.

On the other hand, the non-pathogenic organisms do not produce any mortal symptoms unless in very large numbers. This shows that the tissues of the body have the power of destroying living organisms.
Theories of Immunity.

Many theories have been advanced to explain the bactericidal power possessed by the body, but no one is in itself sufficient. And in view of the recent researches in bacteriology, particularly serum-therapeutics, regarding immunity and the different methods by which it may be produced. They have demonstrated the futility of formulating a theory which would be applicable to all diseases caused by pathogenic organisms.

Exhaustion Theory (M. Pasteur)

"During an attack of an infectious disease, the pathogenic micro-organisms, in its multiplication in the body of a susceptible animal, exhaust the supply of some substance necessary for its development. That this substance is not subsequently reproduced and that consequently the same pathogenic germ cannot again multiply in the body of the protected animal."

This theory does not explain natural immunity, and, if it were true, we would need to have
for small pox germs, material for scarlet
fever, typhoid.
This view is now untenable.

Retention Theory. Chauveau. 1880.
"Certain products formed during the develop-
ment of a pathogenic micro-organism in
the body of a susceptible animal accumulate
during the attack and are subsequently retained,
and being prejudicial to the growth of the
particular micro-organisms which produce them,
a second infection cannot occur."

E.g. products of fermentation of Bacillus myces
Arvensis are prejudicial to their own growth.
"Aspergillus Niger develops a substance which
is prejudicial to its own growth" (Paulin)

This theory is scarcely tenable, as it is
difficult to conceive how a person who has
had attacks of several diseases causing
the different materials in his body for so
long as acquired immunity sometimes lasts.

E.g.? typhoid?
This theory depends upon acquired tolerance to the toxic products of the pathogenic bacteria.

American Journal of Medical Science. April 1881.
Sternberg says: 'The view that I am endeavoring to elucidate is that, during a non-fatal attack of one of the specific diseases, the cellular element implicated which do not succumb to the destructive influence of the poison acquire a tolerance to these poisons which is transmitted to their progeny, and which is the reason of the exemption which the individual enjoys from future attacks of the same disease.

'If we inject a little quantity of the culture fluid with its contained bacilli into the circulation of a living animal, not only does no increase and no patho-morphic change occur, but the bacilli introduced quickly disappear and at the end of an hour or two the most careful microscopic examination will not reveal the presence of a single bacterium. This difference we ascribe to the vital properties of the fluid as contained in the vessels of the living animal, and it
seems probable that this vital property is in the white blood corpuscles, and the white blood corpuscle as an ameba digests and assimilates the protoplasm of a captured bacterium, thus putting an end to the possibility of it doing any harm. In the case of a pathogenic organism, we may imagine when captured in this way, it may share a like fate if the captor is not paralyzed by some potent poison evolved by it, or overwhelmed by its superior vigour and rapid multiplication. It is evident with a contest of this kind, the balance of this power would depend upon circumstances relating to the inherited vital characters of the invading parasite and of the invaded leucocyte. Examples of totemism of drugs are seen in opium, tobacco, strychnic.

The theory of vital resistance to toxic products evolved by pathogenic bacteria is also supported by numerous experiments which show that natural or acquired immunity may be overcome when these toxic products are introduced in excess or when the vital resisting power of the
animal has been reduced by various agencies.

Boucharde showed that very small doses of a pure culture of Bac. typhosus are fatal to rabbits when at the same time a considerable quantity of a filtered culture of the same bacillus is injected into the vein. The animal could have withstood the filtered culture alone, or the bacilli injected under the skin, but when the vital resisting power has been reduced by the filtered culture, the bacilli multiply and a fatal result follows.

Rodger, Nocard, Roux and others have proved that animals who have a natural immunity against certain diseases can be made to succumb to these diseases when the vital power of the heart is reduced.

In view of the results of recent researches, both experimental and otherwise, which show that in certain cases at least, acquired immunity depends upon the formation of antitoxins in the body of the immunised animal, the theory of immunity under discussion cannot be accepted as a sufficient explanation of the facts in general.
It does not explain the modus operandi of this vital resistance or reactive change, but simply affirms that the phenomena in question depend upon some acquired property residing in the living cellular elements of the body.

This theory fails to explain many of the important phenomena during an attack of an infectious disease. For example, the definite duration of certain diseases as pneumonia, scarlet fever. It also fails to explain the regular temperature charts in many infectious diseases.

Theory of Phagocytosis (Metschnikoff)

Hod in 1878 in his work on "Traumatic Infectious Diseases" on mouse septicemia. He said, "The relation of the bacilli to the white blood corpuscles is peculiar, they penetrate and multiply in their interior. One often finds that there is hardly a single white corpuscle in the interior of which bacilli cannot be found. Many corpuscles contain isolated bacilli only;"
others have thick masses in their interior, the nucleus may still be recognised, while in others the nucleus can no longer be distinguished, and finally the corpuscles may become a cluster of bacilli, breaking up at the margin, the origin of which one could not have explained had there been no opportunity of seeing all the intermediate steps between the intact white blood corpuscles and their masses.”

In 1881, Sternberg said that “the white blood corpuscles may have the office of picking up and digesting bacteria which by any means may find their way into the blood.” In 1884, Metchnikoff offered experimental evidence in favour of this view. Metchnikoff knew that a certain species of Daphnia, which is subject to fatal infection by a torula resembling yeast fungus. Entering with the food, this fungus penetrates the walls of the intestines and invades the tissues. In certain cases the fungus does not prove fatal, owing, as Metchnikoff asserts, to the fact that the fungus cells are seized upon by the leucocytes which appear
to accumulate around the invading parasite (Chemiotaxis) for this special purpose. If they are successful in overpowering and destroying the parasite, the animal recovers, if not, it succumbs to the general infection which results. In a similar manner Metchnikoff supposes, pathogenic bacteria are destroyed. Numerous experiments have proved this to be the case, e.g. gonococcus, mouse septicaemia. Plasmodium of Malaria penetrates by ameboid movements into the interior of the Red Blood Corpuscle.

Lecture on Phagocytosis and Immunity.
Delivered at the Institut Pasteur, Dec. 20, 1870.
Metchnikoff said:

The leucocytes which take up the microorganisms are:
1. Large mononuclear leucocytes whose prominent nucleus is at times lobed or reniform, which stain well with aniline dyes and possess much protoplasm and a true ameboid movements = Macrophage.
2. The small form, also staining well,
but either multinuclear, or in the process of breaking up = microphage.

In general a well marked phagocytosis is associated with diseases presenting essentially a chronic development; it is in affections such as tuberculosis, leprosy, etc., that the specific bacteria are most readily taken up by the phagocytes; it is here at the seat of the disease that we meet with innumerable phagocytes in which lie the individual microorganisms. The phenomenon of phagocytosis is most often but recovery in operation from the very onset of the disease.

"Immunity and recovery are very intimately connected and that one can pass by slight gradations from the resolution of a disease to the production of immunity so it is that in inoculating refractory animals, that the microbes to whose action they have been rendered immune, it is found that the parasite begins to develop, but from the onset a reaction on the part of the organism shows itself, accompanied by
a considerable emigration of leucocytes, which soon include bacteria in great numbers. "Very often it is possible to determine absolutely that the parasites are killed within the phagocytes; after inoculation refractory animals with bacteria, an exudate of white blood corpuscles toward the region of inoculation followed by the inclusion of bacteria, and by their death, is seen to occur. These stages can be followed in the case of tubercle bacilli invading animals which are more or less immune."

"The giant cells of chronic tuberculous are in fact huge multinuclear phagocytes and here the intracellular destruction of bacilli is more clearly demonstrable, in as much as the microorganisms exhibit such very evident signs of degeneration. The bacilli swell, their enveloping membrane becomes thickened and highly refractive and in time the contents lose their power of fixing the staining material, so that eventually nothing is left but slightly yellowish forms; recalling in proportion and position the enlarged bacilli and their
shadowy bodies unite into small masses of amber-like appearance."

"Analogous transformations never being observable outside the phagocytes, that is to say, either in culture or in evacuated masses, these changes may well be regarded as due to an specific action upon the part of the giant cells."

"These facts lead us to admit that the influx of phagocytes to an invaded region and their bactericidal properties, are mechanisms which serve to ward off bacterial attacks and to maintain the integrity of the organism."

"When chemiotaxis is negative, the parasites freely propagate themselves and induce the death of their host. This chemiotaxis is not immutable and the cells can become accustomed to substances from which they shrank at first. A negative chemiotaxis may thus become transformed into a positive chemiotaxis. Such obataxis in acquired immunity"
The theory of phagocytosis cannot be accepted in its original form. Since the discovery of the method of immunization by injections of filtered cultures of antitoxin or of antimicrobial sera, immunity must be regarded as due to the accumulation in the blood and tissues of substances which have the property of countering partially or completely the products by which the pathogenic bacteria produce their poisonous effects. The phenomena of phagocytosis cannot be regarded as the cause of immunity but may be considered as an important factor in maintaining the organism germ-free.

Humoral Theory.

This theory was propounded by Niitot, Buchner, Behring and others who established the fact that recently drawn blood of numerous animals possess decided germicidal powers. Buchner says that this property belongs to the fluid part of the blood and not to its cellular elements. This power differs greatly in different species, is prompt in its action
but limited as to the number of bacteria which can be destroyed by a given quantity of blood serum. When the number is excessive, development occurs after an interval of time during which a limited destruction has taken place. It would appear that the element in the blood to which this germicidal power is due is neutralised in exercising this power, and has independently of this i.e. the blood serum has the property of being an excellent culture medium for bacteria, and abundant development takes place when this germicidal power is destroyed.

Buchner ascribed this power to an albuminous substance in the blood serum.

Hankin in 1891 published the results of his researches confirming this view, he separated a globulin from the spleen and blood serum possessing germicidal properties.

So far as active immunity is concerned it may be held as proved that certainly the appearance of immunity is accompanied by changes in the serum, by the development of antitoxin or antimicrobic substances.
and these substances are products of cellular action brought about by the presence of bacteria or their toxins. And considerable amount of evidence has been brought forward by Metchnikoff, Bordet and others to show that bactericidal substances and the indirectly bactericidal substances of antitoxic sera are derived from leucocytes. In this way the theory of phagocytes has undergone modification. Similar evidence with regard to the origin of antitoxic substances is wanting.

Antitoxine Theory.

This theory was propounded by Behring and Kitasato who found that blood serum of animals rendered immune was capable of conferring immunity on other animals. The injection of toxic products of pathogenic bacteria lead to the development of substances in the blood to which the term "Antitoxine" was given. This antitoxine neutralises or destroys the injected poison, and blood serum which has thus been rendered
Antitoxin can be utilized to confer immunity to other animals.

How the presence of these toxic products in the first instance brings about the formation of antitoxins by which they are neutralized has not yet been fully explained, but that such antagonistic substances are produced either by injections of toxins or by an attack of an infectious disease has been sufficiently demonstrated by the recent researches of Ogata, Behring, Kutsate, Tajironi, Brothor, P. Klemperer, T. R. Fraser, and others.

25. Ogata and Jazukara, in a series of experiments made in the Hygienic Institute at Tokyo in 1890, discovered the important fact that the blood of an animal immune against anthrax contains some substance which neutralizes the toxic products of anthrax bacilli. When cultures were made in the blood of dogs, frogs or of white mice, which animals have a natural immunity against anthrax, Behring and Kutsate obtained similar results with regard to tetanus and diphtheria. Ogata in 1891 separated a substance from the
blood of dogs and of chickens to which he ascribes the immunity of these animals as was also shown by the experiments of Nuttall, Buchner and others. Triggani and Cattani showed similar results in relation to tetanus and named the substance tetanus-antitoxin.

Hankin isolated a substance from the spleen to which he ascribes immunity from anthrax. He obtained this substance from the spleen of the rat which is immune to anthrax. Brothers J and F. Klemperer in 1871 in their important memoir in which they give an account of their researches relating to the question of immunity in animals subjected to the form of septicaemia produced by the micrococci pneumoniae. They were able to produce immunity in susceptible animals by introducing into their bodies filtered cultures of the micrococci, and proved by experiment that this immunity lasted six months. They arrive at the conclusion that the immunity induced by the filtered cultures is not directly due to the toxins present in
the cultures, but that it causes the production in the tissues of an antitoxin. The toxic substance present in the cultures of *diplococcus pneumoniae* they call "pneumotoxin". The substance produced in the body of the artificially immune animal, they call "antipneumotoxin". Fraser and Calmette have had similar results in their experiments with the venom of snakes. By injecting less than the lethal dose of venom into horses and rabbits and repeating these injections at intervals increasing the dose at each injection, they succeeded in rendering animals immune and from the blood serum of the immune animals obtained a substance which is antagonistic to venom. This substance is called "antivenene".

There is good evidence to show that persons who are repeatedly stung by certain poisonous insects—mosquitoes, bees, serpents, acquire a greater or less degree of immunity from the effects of their stings.
Hoch discovered a toxine in cultures of Tubercle Bacilli. This toxine is soluble in glycerine, and when injected subcutaneously into tuberculous animals produces febris reactions and other symptoms. This discovery is one of the greatest importance in scientific medicine and has been confirmed by Philip, Strouss and many other observers.

Chemical Examinations of Tuberculin (Hunter)


2. Alkaloidal substance, two of which can be obtained in the form of platinum compounds and their hydrochlorate salts.

3. Extractives, small in quantity, nature unrecognized.

4. Mucin.

5. Inorganic Salts.


Kühne in his analysis agreed with Hunter and found that Peptone also present and an additional albumose - Aero-albumose.

The following conclusions were reached with reference to its toxic properties:

1. Tuberculin owes its activity not to one
principle, but to at least three and probably more, different principles.

2. Its action in producing local inflammation, fever, and general constitutional disturbance, is not a simple but an extremely complex one.

3. Its active ingredients are in the nature of albumoses, alkaloidal substances and extractives. The action of these is in certain instances antagonistic.

4. Its remedial and inflammatory action are connected with the presence of certain of its albumoses, while its fever-producing properties are chiefly associated with substances of non-albuminous nature.

5. The albumoses are not lost by dialysis; the latter are. By the adoption of suitable methods it is thus possible to remove the substances which cause the fever, while retaining those which are beneficial in their action.

6. The fever produced by tuberculosis is thus absolutely essential to its remedial action.
Iggoni and Cattani have presented some experimental evidence which indicates that injections of Koch's tuberculin into guinea pigs may produce in these animals a certain degree of immunity against tuberculosis and that this immunity depends upon the presence of "anti-tuberculin" formed in the body of the partially immune animal.

Koch's tuberculin was used in many cases of pulmonary tuberculosis as a therapeutic agent but with disappointing results. It is now largely used as a diagnostic agent in cattle.

Action of Tuberculin on Tuberculous Cows.
Numerous experiments on tuberculous cows show that the injection of Koch's tuberculin in these animals, in doses of 30-40 centigrams produces a rise of temperature of about 1°-3°C. This febrile reaction usually occurs in from 12-15 hours after injection. Its duration and intensity do not depend upon the extent of the tuberculous lesion.
it is even more marked, when this is slight than in advanced cases. In non-tuberculous cases no reaction occurs and the experiments made justify the suspicions that tuberculous exists if an elevation of temperature of a degree or more occurs as the result of subcutaneous injections in the doses mentioned. Cattle may be tuberculous and present no apparent symptoms and it is thus important from the point of view of human infection that an early diagnosis should be made.

Prof. Bang (Copenhagen) says the more nearly the temperature approaches 104°F, the more reason for suspicion is there. He gives the record of 230 cases where the value of the method was tested by subsequent post-mortem examination. It is found that with proper precaution the error was only 3.3%.
Immunisation against Tuberculosis.

On considering tuberculosis as a specific infectious disease caused by the tubercle bacillus, and in view of the fact that many infectious diseases bring about spontaneous cures by the formation of antibodies during an attack of the disease, the question naturally arises, does tuberculosis conform to such principles?

Tuberculosis differs from other infectious diseases in that there is no evidence to prove that one attack protects against another, but rather that one attack predisposes to another (Ramsay). Many attempts have been made to confer immunity in animals. Tubercle Bacilli from serefolous glands have been tried, but with little success. Recently experiments have been tried by injecting bacilli from avian tuberculosis to protect animals against bacilli from men. The results have been encouraging and worthy of further investigation.


In his essay in competition for the Weber-Parkes Prize, states that he obtained
immunity in mammals for at least five months, by injection of sterilised fowl tuberculosis directly into the blood.

Dr. Bichnow, in his communication on the vaccine of tuberculosis, at the International Congress of Hygiene, Madrid 1898, says, the vaccine of tuberculosis has not yet been discovered. He would be even sceptical as regards such a result had he not found that birds are much more suitable for this kind of research than mammals. He has obtained an antitoxin which he states can cure declared cases of bovine tuberculosis. (B. M. J. April 23, 1898, p. 1103).

The most important and successful results have been those by Maragliano, who distinguishes between the toxic bodies contained in the bodies of the bacilli and those secreted into the culture fluid. The substance used by him consists of three parts of the former and one of the latter. Commencing with 2 mgs. of the mixture and increasing the dose by 1 mgm. daily, till above
of 40-50 mgm is reached. This latter quantity is injected daily for six months, by which time a high degree of immunity has been reached. Maragliano has tried the serum in 712 cases of human tuberculosis with the following results.

104 appear to have been completely cured
379 improved.
167 remained stationary.
60 grew worse.
The best results were obtained in mild cases.

De Buyzi injected 22 cases with Maragliano's serum and the patients improved in appetite and general condition.

Regnier had good results in three cases. Professor Maragliano, in his communications to the R.M.T. London and to the Med. Congress of Bordeaux in 1895, states that he believes his serum contains the antitoxin of tuberculosis.

And from his experience deduces the following conclusions:

1. Cases with circumscribed foci of disease, with little or no fever and free from the association of active microbes show great improvement.
2. Cases of tuberculous broncho-pneumonia, with diffuse centre of disease, febrile or apyretic, but with few associated microbes, gives hopes of cure if the sanatorium per-\ncured with.

3. Cases of diffuse broncho-pneumonia, with considerable association of microbes, show less improvement.

4. Destructive broncho-pneumonia with cavities, show only slight improvement.

Professor R. Koch. In the Deutsche Med. Wochen. April 1877, published the results of his latest researches on the Active Immuni-

sation by Intracellular Toxines against Tuberculosis. This starts from the familiar fact that in a guinea pig inoculated with tuberculosis, and allowed to die naturally, though tubercle bacilli are found in the lesion on microscopic examination, it is often impossible to obtain culture from these lesions. The last stages in the animal's illness are thus apparently due to the ab-
sorption of the intracellular poisons. Immunisation against such poisons would
thus apparently be beneficial in cases of tuberculosis.

Koch's method of isolation was as follows: Bacilli from young virulent cultures were dried in vacuo, they were then well rubbed up in an agate pestle mortar, treated with distilled water and centrifugalised. The clear fluid was decanted and is called by Koch "Tuberculin O". The remaining deposit was again dried, bruised, treated with water and centrifugalised, the clear fluid being again decanted. This process was repeated with successive residues till on centrifugalisation at last no residue remained. All the fluids were then put together, and these form what Koch calls "Tuberculin K". It differs from "Tuberculin O" and also from tuberculin as originally made, in that it contains the substance present in the bacilli, which are insoluble in glycerine. "Tuberculin O" produces the tuberculin reaction like the original glycerine extract, but "Tuberculin K" only does so in large doses. "Tuberculin K" produces immunity against the original extract.
against Tuberculin \(0\) and against living and virulent tubercle bacilli. Koch succeeded in immunising a number of guinea pigg so that the injection of virulent tubercle bacilli had no effect. He also treated guinea pigg already infected, and for the cure of these the treatment had to be commenced within a fortnight of inoculation. Koch states that in the case of human tuberculosis it is early cases that are likely to benefit most. The cases of phthisis most suitable for treatment are those in which the temperature does not rise above 100.5°F. And no doses is to be given which raises the temperature more than 1/2 degree.

No M. Sandwich. M.D. M.A.O.P. Lancet 18\textsuperscript{77}. Vol. \textsuperscript{III} 600.

Gives two cases of advanced pulmonary tuberculosis in which he used Koch's New Tuberculin with some improvement.


Dr. Hawes gives an account of the treatment of four cases of pulmonary tuberculosis by Koch's New Tuberculin with improvement in all cases while the treatment lasted.


Eve gives three cases of surgical tuberculosis treated with Koch's New Tuberculin, and with some improvement.

4. Immunity by Dead Cultures of Bacteria.

In some cases a high degree of immunity against infection by given germs may be developed by repeated and gradually increasing doses of the dead cultures, the cultures being killed sometimes by heat, sometimes by exposure to the vapour of chloroform. Some consider that in this method only the intracellular toxic substances of the organism are introduced when the cultures have been taken from the surface of the solid medium as agar, but as the surface is moist, some of the extracellular products must be present also. The cultures when dead produce, of course, less effect than when living. This method may be conveniently used in the initial stages of active immunisation, to be afterwards followed by injection of the living cultures. The method has been
extensively used by Pfeiffer and others in the production of high degrees of immunity in guinea pigs against the typhoid, cholera and other organisms."

4. **Action of Dead Tubercle Bacilli.**

The remarkable fact has been established by independent observers that tubercle bacilli in the dead condition when introduced into the tissues in sufficient numbers can produce tubercular nodes. Prudden and Hedenpyle, by intravenous injections into the rabbit of cultures sterilised by heat, produced in the lungs small nodules in which giant cells were occasionally present, but no caseation, and which were characterised by great growth of fibrous tissue. The subject has been very fully investigated with confirmatory results by Strain and Gamaleson, who find that, if the number of bacilli introduced into the circulation is large, there results numerous tubercular nodules with well-formed giant cells and occasionally traces of caseation. The bacilli can be well recognised in the nodules by
the ordinary staining method. In these experiments the bacilli were killed by the
exposure to a temperature of 115° C. for ten
minutes before being injected. Similar results
can be produced by intraperitoneal injection.
Subcutaneous injection on the one hand pro-
duces a local abscess, but in this case no
secondary tubercles are found in the internal
organs. Further in many of the animals in-
cubated by the various methods a condition
of marasmus sets in and gradually leads
to a fatal result, there being great emac-
iation before death.

These experiments which have
been confirmed by other observers, show
that even after the bacilli are dead they
preserve their staining reaction in the tissue
for a long time, and also that there are
apparently contained in the bodies of the
dead bacilli certain substances which act
locally, producing proliferation and to a
less extent, degenerative changes, and which
also markedly affect the general nutrition.
The long period during which the tubercle
bacilli, as compared with other organisms,
retain even when dead their morphological and staining characters, is a very striking feature.

The Influence of the Organism upon Toxines. Metchnikoff (Ann. de l'Inst. Pasteur. Nov. 25. 1877). Metchnikoff has applied the method of comparative pathology to the question of the mechanism by which the animal organism prepares antitoxines, and the laws which regulate their production. By growing bacteria and slowly fungi upon ascitic media containing toxines, he was enabled to show that the virulence of the latter was in most cases diminished and sometimes destroyed. In many cases these microbes have no influence in the production of antitoxines and the idea of preparing them by this method must be abandoned. The animal organism alone being capable of producing antitoxines. He proved that the antitoxic property resides solely in the blood. Metchnikoff concludes that it is not possible to accept the idea that natural immunity depends on antitoxic power, and he further points out that the latter was evolved in the
In regard to immunity against tuberculosis, in many minds there seem no reasons to hope that any effort tending to the production of artificial immunity and to the true explanation of natural immunity will ever be successful, and little can at present be learned from the clinical history of the disease which would lead us to believe that such immunity ever occurs in its natural course, and the recovery from an attack of tuberculosis in any part of the body does not seem to afford any protection against a subsequent and often fatal attack. But it is too bold to deny absolutely the possibility of ever solving this problem in view of the scientific evidence which has been accumulating of late years and which tends to prove that the resistance of the body to the invasion of the tubercle bacillus can be greatly increased by preventive inoculation as has been demonstrated by Koch, Behring and others.
Observations of Numerous Cases.
Cases.

Case I. Examined, December 10th 1893.

Mr. J. D., age 22 years. Composer.

Patient did not complain of anything definite, when he consulted me on 10th December 1893, further than want of his usual vigour and an occasional severe headache. He was examined a fortnight previously for Life Insurance by Dr. Cunningham, Edinburgh. Nothing was said to the patient at the time regarding his condition. But on receiving notice of acceptance from the Insurance Company he was informed that five shillings was to be added to his annual premium. This news made him anxious as to his condition.

General History. Previous health good.

Twelve months ago patient had a severe cold, accompanied by night sweats and expectoration. He says he soon recovered.

It is present condition on general examination.

He is well developed Muscularly.

Height 5 ft 8 in. Weight 10 at 7 lbs.

Family History. Mother died of Phthisis four years ago at the age of 38. Brother died of
Phthisis two years ago at age 22.

On inspection of chest:—Well developed, slight supraclavicular fossae, more marked on right side. Expansion slight.

Palpation:—Vocal fremitus slightly increased at right apex.

Percussion:—Slight impairment of percussion note at right apex.

Auscultation:—A few crepitations to be heard distinctly at right apex, and at base of right lung posteriorly, with bronchial breathing.

Other systems normal.

Diagnosis:—Incipient Pulmonary Tuberculosis.

Treatment:—Guaiaecol Carbonate with Arsenic.

Cod Liver Oil. Syrup of the Hypophosphites.

Iodine externally.

Patient would not leave his work, but took as much outdoor exercise as time would permit. He continued to improve very slowly for eight months when he caught another cold which aggravated the physical signs considerably. At this time I suggested a consultation with a consulting physician. This was agreed to, and the patient was advised to go to the country.
for some months. Patient resigned his position, took a long sea voyage and spent six months in different parts of America.

I examined patient on his return in August 1897. He looked and felt quite healthy and strong, well-coloured and had gained 10 lbs. in weight. No abnormal physical signs. Patient returned to his old employment and still continues to all appearances to be quite cured.

In this case there was never any expectoration and consequently I had no opportunity of examining for tubercle bacilli, but it was considered by the other medical men as a case of Incipient Pulmonary Tuberculosis.

Case II. Examin'd September 19th 1895.

Miss F.A. Aged 16 years, at home.

Complains of Cough. Expectoration yellow and thick, of a typical phthisical character.

Night sweats copious. Losing flesh rapidly.

Duration of illness 18 months.

General History: Patient was quite well till 18 months ago, when she had a severe attack
of Influenza.

Family History: - Brother died of pneumonia
three years ago, at the age of sixty.

General Examination: - Patient is thin, especially
in the chest. Malar flush well marked.

Examination of Chest:

Inspection: - Patient stoops slightly, great
retraction of chest, flatness of chest.
Expansion slight, breathing shallow and
rapid.

Palpation: - Vocal fremitus increased on both sides

Percussion: - Percussion sounds increased. I S.
dullness over upper half of right lung and
over apex of left.

 Auscultation: - Vocal Resonance increased.
Moist crepitations over greater part of right lung.
Voniea at right apex. Moist crepitations at
left apex.

Appetite poor; heart sounds palpable and rapid.
Sleeplessness. Temperature 99.8°F.

Sputum shows numerous tubercle bacilli.

Prognosis: - Very grave.

Treatment: - Patient was placed upon light
diet: milk diet principally. Tonics, quinacrid,
hypodermically and afterwards the Carbonate
of Greyiaco acid with arsenic. She began to improve and the number of bacilli diminished, night sweats almost entirely ceased. Intratracheal injections were then commenced once daily and later twice daily. Under this treatment the expectoration and number of bacilli diminished considerably and patient put on some flesh. This progress continued for about three months when patient had a relapse. The physical signs became more marked and the number of bacilli in the sputum increased too much as to become almost a pure culture.

Patient died on June 13th 1896.

Case III. Examined June 26th 1896.

Mr. J. R. Father of Mr. S. R. (Case II). Age 52 years. Height 5 ft 8 in. Weight 13 stone 6 lbs. Boot-maker. Complains of Cough, expectoration yellow and thick, General debility, night sweats. Patient also complains of having been troubled with a "Summer Cough" with expectoration for the past eight summers.

Duration of present illness: three months.
General history: Previously healthy and strong.

Influenza two years ago.

Family history: One sister died of phthisis.

Son died of phthisis three years ago aged 16.

Daughter died of phthisis 13th June 76, vide Case II.

Examination:

General: Patient is well developed, stout in body, face thin and hollow. Temperature 99\%.

Respiratory System: On inspection chest is large, and expands well.

Palpation: Vocal fremitus increased in right axillary region and left base posteriorly.

Percussion: Dullness marked in same two regions.

Auscultation: Bronchial breathing in right axillary region, no other accompaniments. Numerous moist expectorations over left base posteriorly.

Appetite, fair, losing flesh.

Diagnosis: Pulmonary tuberculosis. tubercle bacilli in sputum in small numbers.

Treatment: Sent to country for one month.

Cod Liver Oil, Syrup of the Hypophosphite, Crocute. Iodine externally.

Prognosis: guarded.

Patient was examined frequently and
improved very satisfactorily.


October 8th 1896. Patient while working along with his assistant suddenly ceased working and became very stupid and continued to ask his assistant repeatedly the same questions, although he received satisfactory answers.

On examination he appeared dull and stupid, and continued asking for a "knell bell". His walk was slightly unsteady. Pupil regular, speech thick. Suspecting some cerebral mischief I put him to bed and gave a mixture containing Potassium Diod.

Patient remained in this condition till Oct 11th 96 when right Hemiplegia developed.

October 13th 96. Consultation with Dr. ByromBramwell who agreed with the diagnosis and gave a very grave prognosis.

Patient died November 6th 96. And during the time from the onset of cerebral symptoms the phthisis became very active.
Case IV  Examin’d. December 22, 1896.

M. A. R.  Aged 22. Height 5 ft. 2 in. Weight 90 1/4 lbs.
Travelled (Commercial). Son of F. R (Case III)
and brother of C. R (Case II)

Complains of: Cough. Sputum white and
streaked with a little yellow mucus. Sweats
on slight exertion. Fainting in the morning.

Duration: One month.

History: General — good.

Family: One brother, one sister
and father died of phthisis as stated
in Cases II and III

Examination: Pale and anxious looking.

Respiratory System:

Inspection: Chest flat, muscular development
fair. Expansion poor.

Palpation: normal.

Percussion: Slight impairment of sound
at left apex.

Auscultation: A few fine expectorations at
left apex. Feeble breathing all over chest.

Appetite: Fair, losing flesh, no night sweats.

Diagnosis: Inefficient Pulmonary Tuberculosis.

Sputum contains very few bacilli.

Treatment: Patient spent one month in
Forces N.B. took internally Cod Liver Oil, Syrup of the Hypophosphites, Iron and Arsenic. Iodoform internally.

January 1897: Patient has returned from forces and feels very strong. No cough. Auscultation: no accompaniments.

May 1897: Patient keeping strong. No physical signs. Weight 9st 7lbs.

August 1897: Patient getting stronger and is going in for gymnastic exercises.

April 1898: Patient has continued to improve and feels stronger than he ever did before.

Case V examined, October 5th 1896.
Mr. C. MacK. Clerk. Age 26. Height 5ft 8in. Weight 9st 13lbs.

Complains of Sciatica of right thigh of two years duration. Patient consulted me for the sciatica which was of a severe nature. Many drugs both internally and externally had been tried but with no permanent good result.

I suggested that sciatic needles and massage should be tried which were agreed to. Three needles were plunged
into the sciatic nerve once weekly, and
the nerve was massaged twice daily.
Immediately after the first needles were withdrawn and while patient was on his
back in bed, my attention was drawn
to the poor development of chest muscles
and the well marked supraclavicular
fossa on the left side. On auscultation,
bronchial breathing and expectoration could be
heard. I asked permission from himself
and friends to examine the chest more
carefully which was done the following
evening along with Dr. Loewne M.D.
Patient had never complained of his chest up
to this time.
On questioning patient closely, he said
that he had had a severe cold eighteen
months ago, with cough, expectoration and
copious night sweats, having to rise two
or three times during the night to dry the
perspiration. Since then he had been gradually
getting weaker and losing flesh, but these
he attributed to the severe pain in the sciatic
nerve and to his failing appetite. There was
slight cough in the mornings and occasionally
during the day, and some expectoration in the mornings.

Previous History: Patient was in Algiers for eighteen months, working as a clerk in connection with mines. He returned home two years ago. No malaria. Had good health while in Algiers.

Family History: Good. No phthisis can be traced.

Present Condition: (October 5th, 1896)

Patient is pale, thin cheeks and anxious as if suffering great pain.

Respiratory System:

Inspection: Chest flat in upper part. Fair expansion, muscles poorly developed. Great retraction in left supraventricular fossa; slight retraction on left.

Palpation: Vocal fremitus increased on both sides.

Percussion: Absolute dullness at left apex.

Slight impairment of sound at right apex.

Respiration: Bronchial breathing and pectoriloquy at left apex. Bronchial breathing at right apex.

Moist expectoration at both apices more marked on left and posteriorly extending
as far down as spine of scapula.

Respiratory breathing.

Alimentary system: appetite poor, bowels irregular.

Hematopoietic system: has been losing flesh during the past eighteen months.

Circulatory system: heart sounds feeble.

Absent aortic sound.

Nervous system: occasional headache.

Intestinal system: occasional night sweats.

Diagnosis: Pulmonary Tuberculous.

Sputum contains small numbers of bacilli.

Prognosis: guarded.

Treatment: On consultation with Dr. Scott, it was decided to send patient to Forte Hydropathic for two or three months.

Cod Liver Oil Emulsion with Eucalyptus.

A syrup of the Hydrophosphate Cresotal.

Iodine externally. Iguanaol also externally.

Copy of Letter from Dr. George A. Milligan, Physician to Forte Hydropathic, N.B.

Dear Dr. Scott, Forte, N.B., Dec. 24th, 1896.

I examined Mr. Mac H. again this morning and was much pleased with the result. I consider him distinctly better in
every respect. The lungs seem to have pretty well dried up, and the morning cough and expectoration are gone. The secretion also has ceased from troubling him; he has not had a twinge for ten days. Yesterday he walked sixteen miles without fatigue. This chest is certainly not a strong one, and he will require to be careful for some time. But I hope you will find he has been benefited by his stay here. He says himself that he has not felt nearly so well as he does now for more than a year.

With Kindest Regards

Yours Sincerely

George C. Milleson

May 1st, 1897. Weight 10st 5lbs (gained 6lbs). Patient still continues to keep well and strong. Has been at his old employment as a clerk since January 1897.

May 1898. No physical signs of anything active. Weight 10st 6lbs. Patient goes in for a great deal of outdoor exercise and gymnastics. Usually employed daily, and
feels better than he has done for some years.

Case VI. Examin'd. September 1875.
Mr. J. B. G. Chancellor and Druggist, Aged 27.
Height 5 ft. 9 in. Weight 9 st. 8 lbs.
Complains of Cough, expectoration yellow and thick, and in small masses. Loss of flesh, right arm aches. Temperature 100.5°F.
Duration: Three years during which he has been under the care of Dr. B. Mitchell, Belfast, and has been improving.
Previous History: Good.
Family History: One sister died of phthisis at age 8 fourteen. Patient is one of a family of fourteen, the others are alive and strong.
Examination: Patient is thin and pale.
Respiratory System
Inspection: Muscular development poor.
Expiration slight.
Palpation: Vocal fremitus increased below right clavicle, over 2nd, 3rd, and 4th ribs.
Percussion: Slight dullness over same region.
Auscultation: Bronchial breathing and numerous expectorations over same region.
Appetite poor, losing flesh rapidly.

Diagnosis: Pulmonary tuberculosis.

Tubercle bacilli in sputum in small numbers.

Prognosis: Guarded.

Treatment: Advised patient to give up business for a few months and go to the country. He made up his mind to go to Dr. Walther's sanatorium, Nordrach, Germany, and remained there for three and a half months.

Patient began to improve after the first week in Nordrach and steadily progressed. Cough and night sweats stopped. Expectoration began to diminish gradually, but continued to a slight extent for eighteen months after his return to Edinburgh. At the end of his 3½ months weighed 12st 12lbs (gained 3st 4lbs). He continued to gain weight after his return and, soon, weighed 13 stones.

April 30, 1898. Patient has continued to enjoy splendid health. Has never been off duty one day from ill health since his return, and continues to carry on a large Chemist and Druggist business. During his stay of 3½
months in Nordrach, patient did not receive
one single dose of medicine of any sort, but
was placed upon the treatment as described
by Dr. Walter, consisting of an open air
life, slow exercise in open air, over-
feeding or rather copious feeding.

Case VII. Examined August 15th 1874.
Mrs. J. B. Faukonser cutler. Age 56. Height 5ft 6 in
weight 17st 3lbs.

Complaints of Asthma, General debility Cough
Expectoration yellow and white frothy Night

Duration of illness—Seventy years.

History—Had a severe cold twelve years ago,
and has had repeated colds since. Influenza
several times.

Previous history, good.

Family history, good.

Examination:- Extremely emaciated, pale
eyes glistening, anxious expression.

Respiratory System:-

Inspection:- Sternal depression due to inspiratory
difficulty, great irritability of muscles all
over body. Expansion slight.
Pulpaion: Local prominences increased on both sides anteriorly and posteriorly on left side.

Percussion: Dullness, slight at both apices, marked on left side posteriorly.

Auscultation: Rhonchi at several parts of chest. Crepitations at right apex in both axillas and left side posteriorly over greater part of lung.

Larynx: Voice husky.

Examination by laryngoscope showed both arytenoid cartilages swollen and right aryteno-epiglottic fold swollen. Thick, dark coloured mucus surrounding box of larynx.

Appetite poor, bowels irregular.

Diagnosis: Pulmonary tuberculosis, advanced, also laryngeal tuberculosis.

Progress: Improves.

Treatment: To give up all work, stimulants, nourishing food at frequent intervals and some of which is to be pre-digested. Gentle outdoor exercise. Intralaryngeal injections once daily.

Tonics: Creosotal, Spiritually-fermented and Balsam.

Patient began to improve slowly and to spend more time in the open air. Appetite improved and patient began to put on flesh.
After the patient had improved so far as to be out the greater part of the day and to take his food better, I placed him upon Cod Liver Emulsions of various kinds, but these his stomach could not digest, and they upset his appetite.

I thought that if the Emulsions could be pre-digested, he might succeed in taking it with advantage, and I consequently got a Chemist to make up the following preparation.

Cod Liver Oil 3viii

Yolks of two eggs.

To be made into a fine emulsion with

Half an ounce of Liqueur Pancreaticus Benzoatae at 37°C.

Allow to digest for three hours and stir further digestion by raising the temperature to 100°C.

for five minutes.

Add: Extract of Malt 3viii

Glycerine 3vii

Hydrophosphites of

Lime and Soda, each granulated.

Essence of Cayenne 3vii

Eucalyptus Oil (globules) 3vfi

To be thoroughly well mixed.

Dose: One teaspoonful three times a day to be gradually increased to one tablespoonful three times a day after food.
This preparation the patient has continued to take for nearly three years and is still taking it in small quantities although he feels well. Other medicines were stopped.

March 1896. Patient continues to improve and is now doing a little work.

June 1896. Patient says he has not been so well for over twelve years.

August 1896. Slight attack of Influenza which has thrown him back a little.

August 1897. Patient still continues to improve and is carrying on a large business, but not employed during the whole day.

April 1898. Patient in splendid health and working greater part of day.

Case VIII. Examined January 13th, 1895.

Miss C.B., daughter of Mr. J.B. (Case VII), Age 22.

This case I need not describe in full. On examination I found patient suffering from Incipient Pulmonary Tuberculosis. She was sent to the country for some months. She is now (April 1898) apparently cured.
These eight cases I have selected from my own private patients as best illustrating the points to which I beg to draw attention.

They show the curability of the disease when taken in its early stages; the benefit, perhaps cure, which may be given even in advanced cases. They also demonstrate the hopelessness of trying to cure, or even arrest the progress of the disease while the patient is allowed to remain under unfavourable conditions as to occupation, confinement in unhealthy surroundings, food, exercise. They are instructive to the physician in so far as illustrating the steps that ought to be taken in combating the effects of the tubercle bacilli, by restoring to its normal standard the lowered vitality of the body which enabled the bacteria to gain a footing and bring about their slow and deadly results.

Cases II, III, IV, VII, VIII demonstrate the contagious nature of the disease, the bodily predispositions, the channels and sources of infection. I am of opinion that the
"A summer cough" complained of for eight years by Mrs. J.R. (Case III.) was an indication of an active period of the tubercular process during the summer months. The patient being a boot-maker, working at home and expectorating about the floor and fire-place, the tubercle bacilli became dry and infected three of his family, the members of which are long, flat and narrow-chested. The influenza was, in each case, a preparation of the soil for the favourable reception of the tubercle bacilli.

As similarly in Cases VII and VIII.
Suggestions
as to
Treatment
and
Prevention.
Treatment.

Although enormous advances have been made in the study of the natural history of the disease (Tuberculosis), it cannot yet be said that we are in possession of the specific cure. The recent researches of Koch, Behring, Strauss, maragliano and others give great hopes that we may yet possess such a remedy in the near future.

Many indications, however, for lines of treatment can be obtained from a careful study of the natural history of the bacilli, of immunity—natural and acquired, of the good results gained in different hospitals and sanatoriums throughout the world, and from the number of subclavicular cases found in the post-mortem rooms. It is now well ascertained from recent researches that from 20 - 30% of all persons dying in hospitals, show signs of healed tuberculosis (Ramsome).

As stated in a previous page—...
to its normal standard the lowered vitality of the body which enabled the bacteria to gain a footing. And once this vitality is restored, to maintain it and as far as possible increase it, and then depend upon the organism to destroy and digest the microbes. But we must bear in mind that "Alterum alterius cura non est," is a "Condicio sine qua non" in success.

One of the first steps in the successful treatment of pulmonary tuberculosis is to remove the patient to a suitable locality, so as to ensure against any chance of reinfection should there be any risk of such and should the patient's condition and circumstances permit. Hence the importance of mountain treatment in specially equipped sanatoriums.

It is well to inform the patient of the serious nature of the disease and the consequences of carelessness. By so doing the patient is most careful in carrying out his physician's instructions and places greater confidence in his medical adviser. The patient should also be informed
that the course of treatment is a prolongation and that patience and perseverance on the part of the patient are the principles of success and of cure in connection with pulmonary tuberculosis.

The plan of treatment should combine hygienic, topical, mechanical and medicinal principles under the constant supervision of a physician.

The hygienic treatment should include life in the open air, large, well-ventilated and comfortable sleeping apartments, exposure to sun light as much as possible, gentle out-door exercises, games of a suitable nature. Plenty of rest in the recumbent posture in open galleries. Careful, copious and frequent feeding. Cold water sponging and baths judiciously applied.

Special sanatoria should be erected for the treatment of consumption on lines as seen at Falkenstein, Görberdorff, Furtan (2000), Nordrach, Reiboldshofen, Leysin and many other places.

In the erection of such institutions they should be well arranged with as
southern aspect; placed upon a dry, pure, well-drained subsoil; a pure atmosphere with abundance of sunlight, a garden well protected from the winds, sheltered verandahs, galleries, or arbours facing the sun; constant and trained medical supervision; and adequate nursing staff.

The details of management are fully described by Dr. Dettweiler of Falkenstein, Dr. Darronberg, Dr. A. Meller, Les sanatoria pour le traitement de la phthisie". Dr. Knopf, Les sanatoria". Dr. Leon Petit and others.

It is not absolutely essential that the localities selected should lie on high altitudes as excellent results are also obtained at many seaside resorts.

The beneficial influence of these places may in large part be ascribed to the good hygienic measures, medical attention, hyper-aeration of the blood, and the large amount of fresh air passing over the body and clothes. Less chance of cross-infections by other micro-organisms. Action of Sunlight. Dr. Renge (Nature, May 23rd, 1895) showed by experiments that sunshine assists guinea pigs in combating
tubercular disease. According to Metchnikoff, the warmth and light of the sun quickens all the vital processes, and so increases the activity of the phagocytes, especially the macrophages. And according to the laws of physiology, the sun is the great source of energy.

The patient should be warned against attending crowded halls, dwellings, theatres, where the atmosphere is often so vitiated. The inhalation of such air renders the bacilli more active. On several occasions I have known some of my patients being much the worse for attending a crowded meeting for two hours. The injurious influence of impure air has been proved by Horsman in the "Weber-Parkes Prize Essay 1897."

The lines of treatment as indicated above are very suitable for those patients whose circumstances will permit of such. But what is to be done for those poor patients who cannot afford to pay for such expensive treatment? It is in the poor and crowded localities where phthisis is most prevalent and its mortality highest (Newsholme Vital Statistics).
And in view of the contagious nature of tuberculosis, we must regard every case as a centre of infection. There would come in the value of including tuberculous in the Infectious Diseases Notification Act 1897. The cases would be notified when at a curable stage and means taken to prevent further extension. For the treatment of such cases I would suggest special hospitals to be erected in country or seaside places, to be conducted on lines as in the sanitoria above mentioned, and to be maintained as other fever hospitals are, or by donations and subscriptions as general hospitals e.g. Craigleith Hospital for Consumption, Edinburgh, Laverrier Homes for Consumption, recently opened at Bridge of Weir.

The success of treatment depends so largely upon the patience and perseverance of the patient and must be continued with not only till the tubercle bacilli have disappeared from the sputum but till the general condition and nutrition of the patient have been restored. It would be practically impossible to keep each patient in hospital for such
a lengthened period, but this is not essential in all cases, as part of the treatment consists in teaching the patient how to live and guard against re-infection and the infection of others. In many cases the disease may have been contracted at the patient's occupation and to return to the same after improvement in hospital would be to light up the quiescent condition and to run the risk of re-infection. In such cases it is wise to suggest a change of occupation, preferably an outdoor one with light work. There are some cases in which the climate of the British Isles does not suit, and emigration to a more salubrious climate may powerfully tend to produce a cure.

I beg to append a copy of a letter received from a patient that I advised in 1894 to try S. Africa. This patient had been ill for eight years and was getting gradually worse every year. Many medicines had been tried but without avail.

Copy. Johannesburg
18 October 1896

Dear Dr. Scott.
Sir,

I sincerely thank you for your kind enquiring about me. I am, thank God, quite well and the climate here agrees with me very well, and am cured from my long illness in Edinburgh, and make a living much easier here. I beg to convey my best respect for the advice which proved to be very successful.

Hoping this note will find you well.

I remain

Yours Respectfully

S. F.

215-9 P.O. Box.
Johannesburg
Immanuel, S. A. R.
Africa.

As regards Mechanical Treatment.
Massage and graduated exercises are beneficial. I have seen excellent results from the judicious use of umbellifer and the "Exerciser".
As regards Medicinal Treatment.
I will mention some of the remedies which I have employed in my own cases.

Intra-tracheal injections.
I have used this method of treatment in many cases and had excellent results. In two cases, however, the condition became worse and I stopped it; both cases were in the advanced stage and both ended fatally, this fatal termination was not due to the treatment as both were too far advanced.

In case VII, Pulmonary and Laryngeal tuberculosis, the intra-tracheal injections were most beneficial. The temperature fell, expectoration diminished, cough ceased and patient put on flesh rapidly. This is the most successful case I have ever seen.

Crescite and its derivatives and compounds.
I have used crescite, crescol, (Carbonate of Crescite) guaiacol and its carbonates very extensively, and can confirm the excellent results obtained by Sommerbrodt.
I refer, Ilintiger, Steck and many others. I found the best way to exhibit the Cresote is to have it mixed with oil and put in capsules or the capsules of pure cresote sometimes caused gastric irritation. The best results however, I have had from Carbonate of Cresote (Cresosate). This I make into an emulsion with yolk of egg and port or sherry or other wine. The best results are obtained from very large doses, beginning with ten minims three times a day after food and increasing the dose to one hundred or more minims in twenty four hours. Guaraced Carbonate with Arsenic I have also tried with good results.

Arsenic and Iron have been beneficial in early cases where there is anaemic.

Hydrophosphates of Lime and Soda, i.e. Syrupo of Hydrophosphate Compound I have used very largely along with Cod Liver Oil and its Emulsions with good results.

As external applications I have used Iodine, Guaraced, Eucalyptus, Cantharidis with benefit.
In cases where the ordinary preparations of Cod Liver Oil could not be borne, I have found the preparations suggested on page 167 to be most beneficial and can be continued with for years if necessary.
Suggestions as to prevention.
Contagion of Tuberculosis.

There is considerable evidence to show that the ancients believed in the contagious nature of tuberculosis. Galen placed phthisis among the contagious diseases. Morton, Valsalva, J. Frank, Swieten believed in the contagion of phthisis. Morgagni avoided making autopsies of those who died of phthisis. Laennec was also favourable to this view and said it was a long time before it became contagious. Andral had seen cases in which phthisis had been contracted by persons sleeping in the same bed with phthisial patients, and said the frequency of phthisis was favourable to the view of contagion. Stobbe in 1835, having asked the opinion of many medical men, several knew of cases in which there had been double transmission, e.g. from wife to husband, and from the same husband to his second wife. Holohan found that in times of peace phthisis was more common among the soldiers than in times of war, and said it was due to overcrowding in their barracks. Bergeret gives thirteen cases of transmission of phthisis.
In 1874, Hermann Weber communicated to the Clinical Society of London a study of phthisis by contagion among married couples. He had observed 68 couples in which the husband or wife was consumptive (39 times the husband, 29 times the wife). Only one of the husbands of the 29 women developed phthisis, while 9 women of the 39 husbands had been contaminated.

No evidence of the contagiousness of pulmonary tuberculosis could be more convincing than the examples given by IsadorStraus, La Tuberculose et son Bacille, page 448.

1. John A—— born of phthisical parents, married Antoinette A—— very healthy, without hereditary antecedents. Signs of phthisis developed very soon in John A—— he died. His wife married again and shortly after succumbed to phthisis after having transmitted the disease to her second husband. The malady was not arrested there for in the last months of the disease, Antoinette having had the attendance of one of her nieces, Marguerite M——, married to Joseph B——, contracted the disease; she was of healthy parents.
Marguerite M. died of phthisis, having transmitted the disease to her husband, who also died."

(Dialectic, these cit., p. 79)

2. "A family of labourers, composed of father, mother and three boys, of vigorous constitution and without hereditary taint. The eldest son became a soldier and contracted phthisis in his regiment; he returned to the village, his mother nursed him, she became phthisical. The eldest son, the youngest and the father all suffered the same fate successively. The father was attended by a charitable neighbour who also became phthisical and communicated the disease to her husband."

(Bergeret, mem, cit.)

3. A young girl of a healthy family consisting of father, mother, a boy and two girls, left her village to go to nurse a young phthisical patient whom she did not leave for an instant during a month. On returning to her family she died of consumption. Her younger sister nursed her, she was a perfect type of a stout country girl, she was infected with the maledy and died. Phthisis was arrested in this family because they isolated the second
patient. They took care to make the patient spit into a closed vessel, and they kept the fire burning night and day to purify the air."

Bergeset, ibid.

4. "A young girl returned to her family having contracted phthisis in a boarding school, and of which she died. She was the eldest, the sister who followed her, inherited her chamber and her wardrobe, she also died of phthisis. The third sister used the chamber and garments, she also succumbed to phthisis. The parents were of good constitution and remained well."

(Ulster, Union med. 1868, p. 100)

5. "A man aged 26, having had several hemoptysis and other pulmonary symptoms, married a young woman perfectly healthy and belonging to a healthy family. He died of phthisis four months after her first confinement. Two years after this he married another woman aged twenty-one, very healthy, she died of phthisis two months after her second confinement. He married a third time, this woman was robust and without hereditary antecedents. She died of general phthisis. The husband died of phthisis some time after."

(St. Weber, loc. cit.)
6. 'X'—a house-surgeon of hospitals (1846), of excellent health, no tuberculosis in the family, lived with a woman who died of consumption. He attended her to the end of her illness. Some months after the death of that woman, he had haemoptysis and rapid tuberculosis to which he quickly succumbed. He himself at that early date had no doubt as to where he had contracted the disease.'

(Buegny, Bulletin de la Soc. méd. des Hôpitaux, 1886, p. 106).

Deboué in his lectures tried to show that tuberculosis was always contagious and parasitic and that no one became tubercular who did not receive from the sputum the germs of the disease. He also drew attention to the frequency of the disease among the chronic in hospitals and said that the hospital became a veritable centre of contagion. In Straus, p. 449.

Leperan drew attention to the frequency of phthisis among infirm soldiers in France.

Attention has also been drawn to the enormous death rate from phthisis in armies, prisons, barracks, among men in convents, among the
In 1853, R.M.A. (Collective Investigation Committee) 10,000 members. Asked: How many cases of transmission of phthisis have you observed taking place from one person to another? 263 answered, in the affirmative.

158 times among the married.
119 times from husband to wife.
69 times from wife to husband.

The Medical Society of Berlin made a similar enquiry.

46 observations. 6 rejected.
40 cases: 19 men, 21 women.

23 of marriage contagion.
11 from husband to wife.
12 from wife to husband.

In 9 cases it had been transmitted among parents.

1 case by milk from a tuberculous cow.

"The children of phthisical parents are more frequently attacked than those of healthy subjects." (Strauss p. 489)
"It is not astonishing that the wife should be infected more frequently than the husband, because she is more sedentary, more devout, more delicate, and consequently runs a greater risk. Not only is the wife more exposed to the infection by her pregnancy, accouchement, suckling, but her work is in the house, and she does not leave it day nor night, and in the chamber in which is her phthisical husband, the emanations and secretions. When the wife is phthisical, on the contrary, the husband is generally obliged to travel outside and he is confined in the contaminated air only during the night." (8 times)

There are very few practitioners whose attention has not been drawn to cases of phthisis in which it was quite evident the disease had been communicated from one to another. And I am informed by a practitioner of long experience that he has known of wives nursing their phthisical husbands. The wives, robust and of healthy families, contracting the disease and dying dead before their husbands. The long duration of the period of incubation of phthisis is an element
which renders the question of contagion more difficult.

Regarding geographical distribution, it is independent of climate being worldwide. Rare in islands and sparsely populated districts and high altitudes. Common in towns and especially in crowded localities where there is little sun-light and the ventilation very bad. Ramson in his recent researches shows that the tubercle bacilli can grow in dark, badly ventilated places where the air is initiated, thus proving that the bacilli are saprophytic as well as parasitic.

Corbet has demonstrated by experiment that in the dust of apartments and hospitals occupied by phthisical patients, tubercle bacilli are very commonly present in sufficient numbers to induce tuberculosis in guinea pigs inoculated in the peritoneal cavity.

Bullinger, Hirschberger, Woodhead and others have found tubercle bacilli in the milk of tuberculous cows when the udder was affected and induced tuberculosis in animals by inoculation. Woodhead and others found tubercle bacilli in the flesh of tuberculous animals.
and on the flesh of non-tuberculous animals caused by the hands of the butcher. He also proved that ordinary cooking did not destroy the bacilli in the interior of the meat.

Report of Royal Commission on Tuberculosis 1893.

Sanitary Record, July 1897.

Williams proved the presence of tubercle bacilli in the ventilating shaft of Brompton Hospital by plate cultures.

Klein found that guinea pigs kept in the ventilating shaft became tuberculous.

Cornet produced tuberculosis in rabbits by inoculation with dust from the walls of a consumption hospital. Tubercle bacilli have also been found in the urine and faeces.
Sources of Infection.
The sources of infection of tuberculosis are deserving of the closest attention to enable Medical Officers of Health and the public generally by preventive measures to diminish the prevalence of the disease.

All observers agree that the spu- tum is the greatest source of infection. When moist it forms a suitable medium for their growth and they can retain their vitality for months. Even when dry they can remain alive for 8-12 weeks.

Milk from tuberculous cows with the udder affected is another source. Butcher meat to a much less extent.
Modes of Inoculation.

1. By Inhalation.
   Hussain, Koch, and others have proved this to be the most frequent mode.

2. By Ingestion of milk, butcher meat, woodchips, and others.

3. By Inoculation.

4. From the mother to the child in utero (Strasop323).

Action of Sunlight on Tubercle Bacilli.

Hochst in his address before the North International Congress (Berlin, 1890), says that the direct rays of the sun will tubercle bacilli in from a few minutes to several hours, according to the thickness of the layer; they are also destroyed by diffuse sunlight in from 5-7 days when placed near the window.

The conclusions arrived at by Arthur Semon in his experiments are (Weber-Parker Prize Essay):

1. That finely divided tuberculous matter, such as pure cultures of the bacillus or tuberculous matter derived from sputum in day-light and in free currents of air, is rapidly deprived of virulence.
2. Air has some disinfecting influence even in the dark.
3. In absence of currents of air bacilli retain their virulence for long periods of time.
From the vast amount of literature that has accumulated on the subject of tuberculosis, it is only too evident what measures should be adopted in order to still further reduce the prevalence of this disease. From a study of the Vital Statistics of phthisis by Voorhies, Latham, and from the chart given by Rance in his Weber-Barker's Prize Essay 1897, it is clear that the death-rate is gradually diminishing and that the disease is preventible. The chart given by Rance shows the decline in the death-rate from phthisis in England and Wales from 1838 to 1895. In 1838 it was over 38 per 10,000 living, in 1895 it was nearly 14. In other words, the disease had diminished by nearly two-thirds, and if the decline continues for another thirty years at the same rate it will have entirely disappeared. Dr. Latham also shows that the London phthisis rate for the past 10 years, there was a diminution of more than 300 per million in 10 years. A total gain in ten years of 1350 lives. And, grouping together all the different forms of tuberculosis there is a decrease that means the saving of at least 75,000 lives every year in the present populations of England and Wales.
And at the present time nearly 6,000 persons die of tuberculosis annually in England and Wales.

What is required most of all is a wider spread knowledge of the disease among the masses, the sanitary education and co-operation of individual members of the community. The public are aware that contagious diseases are preventable, they should be made to understand that tuberculosis is also preventable and curable and that their lives and health depend to a great extent upon the actions of one another.

The measures which I wish to suggest:

1. Compulsory Notification. Tuberculosis to be included in the "Infectious Diseases Notification Act."

2. Disinfection and Isolation.

When a case is notified to a Medical Officer of Health, steps would be taken to isolate the patient if desirable. Instructions given how best to guard against re-infection and infection of others. I have in all cases instructed the patient and friends to
immediately destroy the sputum by spitting into pieces of paper or cloth and burning them or into vessels containing a strong solution of Chlorinated Lime or 5% Solution of Carbolic Acid. And when out of doors to use old pieces of cloth to be burned on returning home.

In some cases I have recommended Dettweiller’s Spittoons or an ordinary wide-mouthed stoppered bottle containing 5% Carbolic Acid.

In every case of death from phthisis and in cases where I was suspicious of the germ lurking about the rooms I advised that the bedding, carpets, etc. be sent to the Fever Hospital for disinfection by moist steam. The paper to be taken off the walls and burned, the walls and floors to be washed with 1 in 1000 Corrosive Sublimate (HgCl₂) and repapered and painted.

In some cases (e.g. Cases III. III. page 137) where more than one member of the family had died of phthisis, I advised a change of house to a healthier locality where they could have more fresh air and sunlight.
3. Hospitals.

Since it has been so conclusively proved that phthisis is a disease which can be communicated from one person to another, we cannot allow phthisial patients to enter the wards of our general hospitals for treatment, because it would be practically impossible to prevent communication between the different patients suffering from other diseases.

J. D. Ebele in his lectures insisted on the fact that the stay in hospital was particularly dangerous, because of the number of phthisial patients in the wards, the hospital became a veritable centre of contagion.

J. Rousseau, Charcot and others have drawn attention to the frequency of phthisis as the last (fatal) disease among the ataxics, epileptic paraplegics, chronic rheumatic, compelled to remain for a long time in hospital.

Hence the importance of special hospitals for the treatment of consumption.

There is no doubt that the great reduction in the death rate from phthisis during the past fifty years has been due to the improved sanitary measures adopted in Britain, and not to notification, hospital isolation, nor disinfection.

As it is now well known that inhalation of the bacilli is the most common mode of infection both in man and animals, that it is a contagious disease and the sputum is the chief source of infection. The various agents which are favourable to the growth and propagation of the bacilli, such as impure air, undrained elucidated, piles, etc., have a bactericidal action of sunlight, fresh air.

It is only too apparent what steps should be taken in order to still further prevent the spread of this malady.

Before sanitary reforms can be carried out efficiently, it is necessary that the sanitary department of every town should be composed of men who have received special instruction in sanitation and certified by examination.
Before any building is commenced, the plans should be submitted to a most careful examination by experts in drainage, ventilation &. Means taken to drain the subsoil and prevent the rise of ground water into dwellings. The soil also to be examined as to its suitability, as to dryness.

Back to back houses to be objected to, loss crowding of tenements. Better access for fresh air and sunlight.

The sanitary officers to visit periodically dwellings, halls, schools, factories, workshops, and to report to the medical officer of health any defects of drainage, ventilation, light &.

The Housing of the Working Classes Act (1890) to be enforced in the case of unhealthy dwellings or areas.

It has also been proved that milk and meat of tuberculous animals are sources of danger. (Reports of Royal Commission on Tuberculosis 1895, 1898). These two sources will be removed if the recommendations of the Commission be adopted.
It is also necessary where there is any family predisposition to improve the resistant power of the body by suitable exercises, advising out-door occupations, and not to marry.

To improve the breed of the rising generations by giving more attention to their out-door exercises, food, etc., much has already been done in this way by the institution of the Boy's Brigade, Volunteers.

It has often been said by breeders of cattle that the greater care they take with the animals they wish to rear as prize animals by keeping them indoors, the more liable they are to become tubercular. The same axiom may be applied to human beings.
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