

THE CAUSES OF TUBERCULOSIS

TOGETHER WITH SOME ACCOUNT OF
THE PREVALENCE AND DISTRIBUTION
OF THE DISEASE

BY

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EDITOR'S PREFACE

IN view of the increasing importance of the study of public hygiene and the recognition by doctors, teachers, administrators and members of Public Health and Hygiene Committees alike that the *salus populi* must rest, in part at least, upon a scientific basis, the Syndics of the Cambridge University Press have decided to publish a series of volumes dealing with the various subjects connected with Public Health.

The books included in the Series present in a useful and handy form the knowledge now available in many branches of the subject. They are written by experts, and the authors are occupied, or have been occupied, either in investigations connected with the various themes or in their application and administration. They include the latest scientific and practical information offered in a manner which is not too technical. The bibliographies contain references to the literature of each subject which will ensure their utility to the specialist.

It has been the desire of the editors to arrange that the books should appeal to various classes of readers: and it is hoped that they will be useful to the medical profession at home and abroad, to bacteriologists and laboratory students, to municipal engineers and architects, to medical officers of health and sanitary inspectors and to teachers and administrators.

Many of the volumes will contain material which will be suggestive and instructive to members of Public Health and Hygiene Committees; and it is intended that they shall seek to influence the large body of educated and intelligent public opinion interested in the problems of public health.

AUTHOR'S PREFACE

THIS book is addressed mainly to those who are interested in the stamping out of tuberculosis. It makes no attempt to deal with the disease from its clinical aspect which has already been treated abundantly by many eminent writers.

The outlook of the author has been that of the experimental pathologist, and it is from this point of view mainly that the problem has been approached. This outlook, though it limits the field, has the compensating advantage that it opens up that aspect of it which is, perhaps, the least familiar.

It is hoped that the book will meet a demand for information on many points about which the author is frequently questioned. For, though notable advances have been made since the subject of the relation of animal to human tuberculosis was first brought prominently forward by Koch's adverse pronouncement at the London Congress in 1901, the researches which have led to these advances are, for the most part, buried in Blue Books or hidden in other official publications. It is, indeed, one of the principal objects of this book to bring together in a handy form these researches, and particularly those of the late Royal Commission on Tuberculosis and the Local Government Board in this country, the Department of Health of the City of New York and the Imperial Board of Health in Berlin.

The greater part of the book will be found to deal with the tubercle bacillus and its varieties, or "types," as they are more generally called. It treats of their distribution, cultural characters and comparative virulence for a number of animal species. In particular the sharpness of characterization of these types and their stability under conditions which, if any, might be supposed to conduce to modification, that is to say

the evidence of their existence as distinct varieties, is inquired into at some length.

Such questions may appear to some to be merely of academic interest. But it is not so. In reality their solution is necessary before a true opinion can be formed of the relative importance of the different sources of infection in human tuberculosis, and they play a practical rôle in the campaign for the eradication of the disease.

This book is addressed, as we have said already, to those who are interested in the stamping out of tuberculosis. And, consequently, it is intended both for those who are and those who are not members of the medical profession. The language has therefore been kept simple and as free as possible from technical difficulties; at the same time it has seemed desirable, in the interest of those who are following, or about to follow, lines of research similar to those dealt with here, to review much original work in considerable detail. It is feared that this survey, extended as it is over many pages, may prove tedious; and for this reason some of it has been printed in small type. Such parts may be passed over without interfering with the thread of the argument. But, indeed, the main defence of a detailed treatment lies in the fact that it should enable the reader to arrive at his own conclusion; and the author is more concerned that he may be held to have presented the evidence fully, clearly, impartially and with criticism which is just, than that he should be pronounced to have dealt with the subject in an agreeable manner.

The earlier chapters of the book deal with the magnitude of the evil imposed by the tubercle bacillus upon mankind, and with its age and sex distribution in town and country. The changes in this distribution, which have been so remarkable a feature of the history of human tuberculosis in the last half century, are described, and attention called particularly to the great diminution of mortality which has occurred among women at certain periods of life. The causes of the wonderful decline in the mortality from tuberculosis which has occurred in these, and to only a lesser extent in all other, classes of the population is briefly touched upon; and evidence is assembled

in the hope of giving credence to the vision which has already gladdened the eyes of some seers that at a day, not too far distant, the world may become rid of this incubus, or at least that tuberculosis shall have ceased to exact an exorbitant tribute and have become reduced to the status of one of the less common diseases.

The part played by personal contagion in the spread of the disease, and the relative importance of individual predisposition and opportunity for infection, or as we may say of "soil and seed," about which such curious fluctuations of opinion have occurred in the past is considered in Chapters IV and V.

On this ancient controversy it is hoped that a new point will be found to have been brought to bear, namely the influence of the *quantity* of bacilli in the infecting dose. This, though recognized, more or less clearly, by certain writers, has, in the main, been strangely neglected hitherto, and evidence of an experimental kind is here brought forward, it is believed for the first time, to establish its importance.

Next follows a consideration of the *portals* through which tubercle bacilli enter the body most commonly, about which erroneous opinions, quite recently, have prevailed in high places. The practical bearing of this question on the decision whether pulmonary discharges or contaminated milk are most to be guarded against is sufficient justification for dealing with this question at large.

The chapters which follow deal with the bacillus itself and its various types, as already indicated, and with the means which are available for their identification.

Chapters XVIII to XXIII treat of tuberculosis in animals. The remarkable difference in histological response to invasion by tubercle bacilli presented by different species is pointed out; but the chief interest is devoted to types of bacilli found in instances of naturally acquired tuberculosis in each animal species, and in the relative susceptibility of that species to infection with each of the three types as shown by artificial experiment. As will be seen, it is not always the type which is most virulent for a given species that is responsible for the majority of instances in it of naturally acquired disease.

Human tuberculosis is treated in Chapters xxiv and xxv from the same standpoint, but at greater length as its importance demands. Each kind of tuberculous disease is dealt with separately, and special attention is given to lupus, concerning which so many problems of interest arise.

Lastly, in the concluding chapter is summarized the evidence as to the comparative distribution of the three types of tubercle bacilli in various animal species and the part, if any, played by each in the various kinds of tuberculosis in man.

Such is the programme of the book. How far the author has succeeded in carrying it out it must be left to his critics to judge; he himself is not unaware of numerous shortcomings, and he would beg his judges to bear in mind the difficulties of the task. On one point especially he would ask indulgence, namely on the classification of atypical tubercle bacilli. For this the time was not fully ripe; fresh facts were coming to light while the book was being put together, so that place for some of them has had to be found in an appendix. This circumstance was however not without its recompense for it conveyed a stimulating sense of the fact that one was dealing with a living and developing problem.

In conclusion, the author hopes that this book may receive a welcome from those who have at heart the victory over disease. And he will feel that he has not laboured in vain if it should lead, in some degree, to a more general interest in the fundamental problems concerning that disease which, without exaggeration, may be described as the commonest, most fatal and, perhaps, as the saddest of those which oppress mankind.

The author's thanks are due to many helpers, and especially to Dr A. Stanley Griffith and to Lieut. C. F. Fox, whose intimate knowledge of the Reports of the Royal Commission has proved invaluable.

L. C.

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CHAPTER I

THE TRIBUTE EXACTED BY TUBERCULOSIS

The Annual Mortality. Its Age and Sex Distribution and the changes which these have undergone in the last half-century.

Tuberculosis is the commonest of all the important diseases of civilized lands. Over 51,000 deaths were attributed to it in 1910 in England and Wales¹. This number was the lowest ever recorded; yet it accounted for more than one death in every ten, and was in the proportion of 1434 to every million persons living.

Large as is this mortality at home, in nearly all other countries it is larger still; and in some much larger. In Scotland the death-rate from tuberculosis is a little higher than in England and Wales, and in Ireland half as high again². In Prussia, in 1910, it was 1510 per million; in Austria 2880; and in Hungary 3480. In the Balkan Peninsula tuberculosis is extremely rife³. In Paris too it is a frequent cause of death; and in a report of the Préfet de la Seine, some few years ago, it was stated that one person in every four who died there was certified to have died of tuberculosis.

Belgium, alone of all countries of Europe, has a death-rate from pulmonary tuberculosis lower than that in England and Wales—and the difference is inconsiderable; and a review of all the countries of the world for which figures are available shows that only in New Zealand, Australia, and Ontario is the

¹ 73rd Rep. Reg. Gen. England and Wales (1910), p. lv. The actual number was 51,317. In 1911 the deaths from tuberculosis of all kinds were slightly more numerous, and numbered 53,120.

² 2150 per million in 1912.

³ In Servia, for example, in 1910 the death-rate from pulmonary tuberculosis was 3437 per million.

mortality from this cause substantially less than it is in this country¹.

But though the number of deaths certified to be caused by tuberculosis is large it probably falls short of the truth; for there is reason to think that a good many deaths which are really due to that cause become included in bronchitis, pneumonia, or some other category. Both to bronchitis and pneumonia are assigned each year almost as many deaths as to pulmonary tuberculosis itself; and there is considerable uncertainty as to the etiology of bronchitis, and of some kinds of pneumonia also. It seems not unlikely then that, in early life, a good many cases of pulmonary tuberculosis get returned under the latter, and still more, towards the end of life, under the former heading². It has even been suggested that the diminution of the mortality from phthisis towards the latter end of life which appears in our records is not a real one, and would disappear if all deaths from senile phthisis were correctly reported; and that the registered mortality from that cause

¹ The death-rates per million from pulmonary tuberculosis (which are probably more reliable than those for all kinds of tuberculosis) were, in 1910 (unless otherwise stated), as follows in some of the principal countries for which statistics are available.

France	1788	
Ireland	1716	(Excluding acute military tuberculosis)
Germany	1421	
Denmark	1201	(1912. Principal cities only)
Netherlands	1189	
Italy	1174	(Including general tuberculosis)
Scotland	1142	(Excluding acute military tuberculosis)
England and Wales	1015	
Belgium	972	
Ontario	932	(1911)
Australia	700	
New Zealand	587	

(Calculated from figures given in the *74th Report of the Registrar General for England and Wales* (1911), pp. 105 *et seq.*)

• These are crude death-rates, uncorrected for sex and age constitution of population, and are therefore only roughly comparable with one another.

See also *73rd Rep.* (1910), p. xcvi.

² It was observed in Sheffield, when compulsory notification was introduced, that some of those who had been notified as suffering from pulmonary tuberculosis came in the end to be certified as having died of some other cause. Matthew Hay also has called attention to the confusion of bronchitis and phthisis in Aberdeen (see footnote on p. 13).

would then increase right up to the end of life, as it does in New York¹.

I. *Age Distribution of the Mortality from Tuberculosis.*

In order to appreciate fully the economic importance of tuberculosis to the community, one must know at what period of life the deaths fall thickest; for it is obvious that diseases which destroy infants on the threshold of life, as, for example, measles and whooping cough, and others which, like cancer, carry off for the most part those whose work is nearly done, are of less consequence to the well-being of the state than such as remove the young adult (after much expenditure of labour and money has been incurred in his upbringing) and many of those who are in the full tide of their activity and upon whom, very often, children and wife or husband are dependent. And tuberculosis does just this; for though it is true that the disease is more fatal in infancy than at any other period of life, yet the great bulk of its mortality falls in middle life².

At the present day, in England and Wales, the incidence of the tuberculosis mortality on the different periods of life is as follows:

Infancy. As already mentioned, tuberculosis is more fatal in infancy than at any other time of life, and most of all in the latter part of the first year. In 1911 the deaths from this cause in the first year formed 6·3 per cent. of the total for the whole of life; those in the second year 5 per cent., and those in the first five years taken together 16·7 per cent.

The distribution of this mortality throughout these five years is shown in the following table, from which it will be seen how greatly it is concentrated into the 18 months which immediately succeed the first half-year of life.

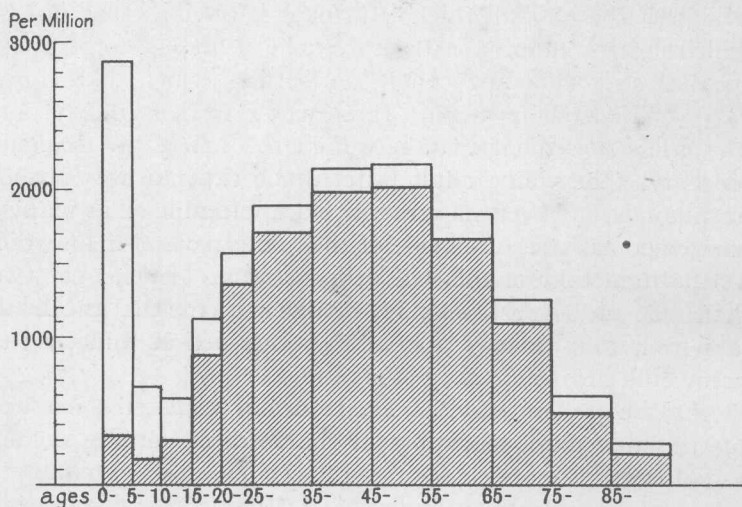
¹ Dr Glover Lyon, quoted by Newsholme in *The Prevention of Tuberculosis*, on p. 24.

² More than one-half of all the deaths ascribed to tuberculosis fall between the twentieth and the fiftieth year of age.

The deaths in 1911 were actually as follows:

Ages	0-5	5-20	20-50	50+		
	8877	8178	27,365	8700	•	•

DIAGRAM I. *The Incidence of the Mortality from Tuberculosis of all kinds and from Pulmonary Tuberculosis at Different Periods of Life, as shown by the mean annual mortality per million persons living at each age period in England and Wales, during the decade 1901-10.*



All Kinds of Tuberculosis.

Ages	0-	5-	10-	15-	20-	25-	35-	45-	55-	65-	75-	85-	All ages
Males and Females	2883	667	586	1125	1576	1892	2150	2163	1838	1246	602	280	1653

Pulmonary Tuberculosis only (shaded columns).

Ages	0-	5-	10-	15-	20-	25-	35-	45-	55-	65-	75-	85-	All ages
Males and Females	327	166	283	873	1370	1708	1983	2004	1673	1095	477	180	1161

(Calculated from the figures published in the Annual Reports of the Registrar General, with the aid of a table giving the mean annual population both male and female at various age periods, kindly supplied by him for the purpose.)