AN INQUIRY INTO THE PRINCIPAL CAUSES OF THE REDUCTION IN THE DEATH-RATE FROM PHTHISIS DURING THE LAST FORTY YEARS, WITH SPECIAL REFERENCE TO THE SEGREGATION OF PHTHISICAL PATIENTS IN GENERAL INSTITUTIONS.

By ARTHUR NEWSHOLME, M.D., F.R.C.P.
Medical Officer of Health of Brighton.

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PHTHISIS (pulmonary tuberculosis) is distinguished from nearly all other infectious diseases by its protracted duration and by the prolonged disability which it imposes upon enormous numbers of the total working population. It is further distinguished by the complexity of the influences which are regarded as affecting its spread or capable of controlling its prevalence. It is therefore of the first importance that the relative values of measures for controlling phthisis should be closely studied, and that special attention should be given to those which promise the greatest yield for a given expenditure. In particular it is important to be aware of any which can be set to work without the delay and expense involved in creating a new service. The present paper is intended as a contribution to this study. The facts collected in it and others of a similar kind deserve more extended investigation than it has been possible for me to give them in the intervals of official work. They are put forward here without any illusions as to the inevitable shortcomings of their presentation but with a conviction that from the economic standpoint they are of fundamental importance in the prevention of phthisis.

The paper contains the results of an inquiry which has engaged my attention for the past three years. In examining into the course taken by tuberculosis in this country for a paper read at the Brussels Congress (1903, p. 461), I was struck by a remarkable coincidence in some local statistics between the amount of decline of the death-rate from phthisis and that of the segregation of the sick in workhouse infirmaries and similar institutions. So far as the influence of such institutions had previously been considered, they had been regarded commonly as a means of concentrating infection upon groups of persons peculiarly unfitted to resist it; and for the institutional treatment of phthisis, with a view to the control of the disease in the community, special sanatoria and hospitals alone had been advocated. Indeed by some singular misconception Dr R. Koch (1901, p. 52), said: "The only country that possesses a considerable number of special hospitals for tubercular patients is England; and there can be no doubt that the diminution of tuberculosis in England, which is much greater than in any other country, is greatly due to this circumstance." In this statement the context makes it clear that he is referring to special hospitals, such as

were used in the past for leprosy; and in this respect Dr Koch's informant was labouring under a misapprehension, as the number of beds for consumptives in special hospitals in England was too small to have had an appreciable influence on the total death-rate from phthisis[1].

The statistics which had first drawn my attention to the effect of institutional segregation on phthisis were merely local. There are few epidemiological students who at some time have not had painful occasion to realise how fallacious local statistics may be; and I was concerned therefore to extend my inquiry into the experience of larger communities. The same coincidence seemed to persist in this larger examination; but even then the evidence was not free from the suspicion that if similar inquiry were made into the course of the other phenomena more usually regarded as causative in phthisis, similar coincidences might be found. This result, had it occurred, would not have been evidence that the coincidences which had appeared in regard to segregation were merely fortuitous; but they would have certainly made it difficult or impossible to estimate even approximately the relative importance of the several causes which had been at work. I proceeded therefore to a similar examination of most of the other phenomena which had been regarded as causally connected with phthisis, and as far as I could obtain materials extended the examination to the experience of various foreign countries. This wider examination gave confirmatory evidence of the influence of most of the well-recognised causes of decrease of phthisis. The extent of this confirmation varied from country to country. In some countries the operation of some causes was wholly masked by countervailing influences, and in other countries their operation seemed even to be contradicted. The only phenomenon which I found to vary without exception with the phthisis-rate was the extent of segregation. I have elsewhere (1905, p. 427) set out some parts of the evidence which I have collected and collated. The present paper sets forth this and some additional evidence in the proper sequence of the argument to which they give rise.

[1] In his Nobel Lecture at Stockholm on Dec. 12, 1905, published in the *Lancet* for May 26, 1906, Koch takes a wider position on the relation of institutional treatment to the reduction of the phthisis death-rate which is consistent with the facts to which I drew attention at Brussels (1903, p. 461) and at Paris (1905, p. 427), and with the inferences drawn in the second of these papers.

The Circumstances and Limitations of the Problem.

The problem is one in which inferences to be valid must be drawn with considerable caution. The conditions determining the successful invasion even of an individual with an infectious disease are highly complex. They depend not merely on the life-history and modes of activity of the infecting organism but also on the far more complex processes of the person attacked; and our biological knowledge will need great extension before an exact statement can be made of the conditions determining successful infection. The complexity of the problem is still greater when we come to consider the conditions which determine the spread of an infectious disease in a community; for in addition to the problems of individual cases, further complexities arise from the economical and other vital processes of the body corporate. The communal complexities are greater in the case of diseases with protracted incubation than in the case of diseases in which infection and onset follow in rapid succession.

An investigation of the prevalence of phthisis has therefore to be worked through complexity of a high order, probably as high as is offered by any epidemiological problem of the first importance.

To obtain assured results it is necessary to respect carefully the limitations which are put on the inquiry by the nature and extent of the material which is available. In the present inquiry the material used consists of the numerical experience of certain countries and districts in respect of phthisis and of certain social phenomena. No attempt has been made to attach to a contributory cause of phthisis any figure expressing its phthisiogenetic capacity. In a community or even in a person exposed to many phthisiogenetic influences it is practically impossible to obtain such a figure, or to set up for any cause an absolute measure of its importance in the epidemiology of the disease. In some cases, however, it may be possible from numerical experience to see whether any relation at all exists between a disease and a phenomenon associated with it, or even to determine which of several such phenomena is the most important. The present inquiry is restricted to this end; and in order that its results and the extent to which they are the necessary consequence of the facts may be clear, some detailed consideration of the method employed is desirable.

The General Method adopted.

If the two sets of figures which measure phthisis and some other phenomenon or group of phenomena are found not to vary uniformly with each other, in either the same or in inverse directions, a causative relation between the disease and the phenomena is not disproved. The relation may be merely masked by independent variations in other operating influences. But if the amounts of disease and of the associated phenomenon always vary in the same or always in the opposite direction and the contagium is always the same, it must be inferred that the disease is related causally to the phenomenon, unless the basis of observation is not wide enough to avoid the influence of local accident. The strength of this inference depends on the width of the basis of observation and the constancy with which the variations accompany or follow each other. In this respect this method differs from the method of intimate local analysis, which in problems suited to it gives such valuable results. In the analytical method width of basis is not of fundamental importance. The degree of probability attaching to a suspected causal connection between a disease and an associated phenomenon investigated by this method depends principally on the intimacy with which the relevant circumstances are known. In the impossible case of perfect knowledge of these circumstances the number of the observations would be almost immaterial; and statistics which in the aggregate are inconclusive may be made significant by breaking them up into smaller groups of which the relevant circumstances are intimately known. With such information national figures may be explained by those of the constituent towns or districts, and these again by a further analysis into smaller communities. Better knowledge and greater certainty may, so to speak, be had in such cases from a small field and a high power, than from a large field and the naked eye. It may be possible to study the incidence of an infectious disease by this analytical method in a district which is self-contained, its population living and dying within its borders unaffected by conditions external to the district, or even where through special circumstances the population is known to be affected by migration and external circumstances on the debit and credit side equally or to known extents. For acute infectious diseases, for instance, in which incubation periods are short, and fairly accurate histories of movements during these periods can be had, such studies may not only be practicable but may often constitute the most effective method of study. In a chronic disease like phthisis with an indefinitely

long period of latency, these necessary conditions are not fulfilled, and it is impossible to use what I may term parochial statistics with any confidence except as hints which may possibly be confirmed by other information, and as illustrations of the mode of action of influences which have been demonstrated independently[1].

In so far as knowledge of the relevant circumstances becomes less complete it becomes important to extend the basis of observation. The need for such extension reaches a maximum in the case of phthisis. Its usually long period of activity, the still longer period during which the disease may be latent, and the great complexity of circumstances which are known to affect its communal infectivity and progress, make it impossible to know intimately any substantial part of the relevant circumstances affecting individual groups of cases. The inferences which parochial, local, or even national figures may suggest must be taken chiefly as so many statements of what is possible, as hints of the directions in which the truth may be sought. Such inferences cannot be considered as proved until they are confirmed by the wider experience to be had from international figures; and the approach to certainty becomes on this macroscopical method the greater

[1] The difficulty of forming non-fallacious conclusions from "parochial" statistics concerning an infective disease of protracted latency and protracted duration may be illustrated by the phthisis death-rates in tenement houses and in the different districts of a large town. It is well-known that the phthisis death-rate is higher in populations inhabiting one room than in those inhabiting dwellings with two or more rooms; and is greatest in overcrowded dwellings of any given size. The association between the phthisis death-rate and size of dwelling and overcrowding is complex, and its full teaching can only be secured if, before drawing inferences as to the effect on phthisis of the increased infection and lowered resistance accompanying overcrowding, we ascertain among other things to what extent the inhabitants of these overcrowded tenements drifted into them after and perhaps because they had become consumptive. Similarly, in comparing different districts of a large town or even small towns with each other, allowance has to be made for the influx of consumptives into poorer districts as they go down in the social scale. If this can be done,—and it implies a complete knowledge of each patient's history and of the duration of the latent period of his disease,—it has further to be noted that inasmuch as the opportunities for infection by phthisis vary enormously in different districts the effect of measures against infection must correspondingly vary. We must therefore either compare the influence of such measures on large masses of population in whom this source of error is likely to be equalised, or on small aggregations having a like composition. It is evident for instance that efforts against infection may have had a greater effect on the death-rate from phthisis in a district whose death-rate from this disease is still 2 per 1000 than similar efforts in another district of a different social stratum whose death-rate from phthisis is only 1 per 1000. For the above and other reasons, local statistics of phthisis cannot be used without fallacy, unless corrections are made which only the most intimate investigation will render practicable.

as the field of observation becomes larger. Width of observation has to be used in fact to replace the intimate knowledge of relevant circumstances which the conditions of the problem do not allow; and with an adequate width of observation causal connection between a disease and a phenomenon can be inferred validly from a sufficient constancy of direct or inverse variation between the figures expressing them, even though interacting influences prevent any quantitative relation from appearing. Among several such phenomena that one will be inferred rightly to have had the closest causal connection which has most constantly varied with the course of the disease either simultaneously in different communities or at different epochs in the history of individual communities.

The Special Conditions.

(*a*) *The Assumption of Constant Virulence.*

For this method to be applicable without corrections which are usually impossible it is, as already indicated, necessary that the contagium shall have been the same throughout the whole periodunder investigation, and in all the countries from which the experience is derived. As has been pointed out by Sir Shirley Murphy, the variations which have occurred in the death-rate from phthisis would be explicable on the assumption of a sufficiently great variation in virulence of the tubercle bacillus. If there were evidence to justify such an explanation in the case of phthisis, it would be almost useless to attempt to derive from statistics information as to its possible causes, unless there was evidence that changes of virulence were caused by external circumstances which could be expressed statistically. Such cyclical and sometimes secular variations are well recognised in certain acute infectious diseases. There has been, for instance, a marked decline in the virulence of scarlet fever, and this decline as Sir Shirley Murphy (1905, p. 120) pointed out occurred at different epochs in different countries. There is however not only no such evidence for the phthisis of the last forty years, the period to which the present inquiry relates, but the available evidence seems to point wholly in the other direction. Throughout that time the clinical types of the disease appear to have been of the same character. The descriptions of Graves, Watson, Walshe, Austin Flint, and others show the same varieties of type and duration as are now seen. No distinction has been found at any time between the clinical experience in different countries. It is probable that under more

rational treatment consumptives now live longer than formerly; but this circumstance, giving longer persistence to each human focus of infection, would probably fail to reduce the death-rate from phthisis, were no other influences at work. The evidence therefore shows no ground for assuming that any material alteration has occurred in the contagium during the period and in the countries in question and some reason for believing that it has been substantially unaltered.

(*b*) *The Limits of Accuracy of the Statistical Material.*

I propose to assume that the official figures of amount of tuberculosis in different countries are fairly accurate, or inaccurate only within such limitations as will be indicated in the course of this paper. The reasons on which I base the conclusion that inaccuracies are within limits that do not interfere materially with international comparisons are given in some detail elsewhere (1905, p. 32).

(*c*) *The Methods of exhibiting the Statistical Results.*

The statistical results are exhibited in the usual form of tables, sometimes also shown as curves. I have also calculated the "coefficients of correlation" in those cases where the variations of phenomena can conveniently be compared with corresponding phthisis-rates. These coefficients summarise the degree of co-variation or of independence of two sets of figures. They add nothing to the facts; but in substituting a definite measure of the extent of co-variation for the merely general impression produced by tables or curves, they permit the simultaneous comparison of a considerable number of sets of data to be made far more accurately and effectively than is possible without their use.

As the significance attached to correlation-coefficients by different writers is not always the same it may be well to state shortly their import in the present paper.

The coefficient of correlation between two columns of figures is a number, never greater than unity, which expresses the closeness with which deviations of figures in one column from their mean value follow deviations in the corresponding figures of another column from their mean. In the case of perfect direct correlation, *i.e.* when all corresponding deviations from mean values vary in the same sense of excess or deficiency and bear the same ratio to each other, the coefficient is 1; in the case of perfect inverse correlation, where the senses of variation in corresponding pairs of figures are opposite and the ratio of their magnitudes is the same, it is -1; and it may have any intermediate values according to the nature of the case. The closer the coefficient is to ± 1, the nearer is the approach to constant co-variation of the pairs of figures; and where no influences but those represented by the figures are operating, a high correlation

coefficient on a sufficient number of figures is the numerical expression of strong inductive evidence that there is some connection—whether causal or otherwise is a matter for subsequent discussion—between the phenomena represented by the two groups of figures. In practice it is rare for two groups of phenomena to be free from disturbing influences; and the correlation-coefficient measures therefore for practical purposes the influence of one group of phenomena on the other to such extent as it predominates over or is assisted by the other influences in operation. Within certain limits the manner in which the deviations are measured may vary according to the circumstances of the case. The effect of any such variation would however only be to alter the final result by a relatively small amount; and coefficients of correlation, computed on any single system, represent the closeness of relations between such curves as appear in this paper far more distinctly than any general impression that can be derived from mere inspection of the curves. The usual form taken for this coefficient is the ratio of the arithmetical mean of the products of corresponding deviations in each group of figures from the arithmetical means of the values in the respective groups to the product of the square roots of the arithmetical means of the sums of these deviations squared; that is to say

$$\frac{\frac{1}{n}\Sigma(xy)}{\sqrt{\left(\Sigma\frac{x^2}{n}\right)}\sqrt{\left(\Sigma\frac{y^2}{n}\right)}},$$

where x and y are the deviations from the arithmetical means of the respective series.

To discuss the precise mathematical reasons for the selection of this form of coefficient and the processes by which its validity is demonstrated would extend the scope of this paper beyond the available space. It is worth while, however, to verify the fact that, by whatever mathematical considerations the coefficient in question may have been obtained, it is a quantity of which the magnitude must always depend on the closeness with which the phenomena to which it refers stand in some relation to each other. This may be seen very shortly. It can be shown by simple algebra, and is here assumed to have been proved, that this fraction can never be greater than 1. If the two groups of phenomena were unconnected by any causal link whatever, that is to say, if there was no reason why a deviation x_n of any figure in one group from the arithmetical mean of that group should be accompanied by a deviation $\pm y_n$ of dependent magnitude and constant relative direction in the corresponding figure of the other groups, then in any long series of pairs the deviation of figures in each group from the arithmetical mean would be as often positive as negative, and their values would be distributed evenly on each side of the mean. Hence the products of the pairs of deviations (xy) of which the sum (Σxy) forms the numerator of the fraction will be as often positive as negative, and when added together with their proper signs will exactly balance each other, and the sum will be 0. In other words when there is absolutely no causal link between the phenomena, this correlation-coefficient will become 0. If there is any causal link, then to such extent as they are governed by the causal relation the figures expressing the phenomena will always deviate from their respective arithmetical means in a common direction or always in opposite

directions; the members of every pair of corresponding deviations will in every case be either both greater or both less than the arithmetical mean of their respective groups (*i.e.* always $+x$ and $+y$ or always $-x$ and $-y$), or else in every case one will be greater and the other less (*i.e.* always $\pm x$ and $\mp y$). Therefore the products of which the sum enters into the numerator will either always be positive or always be negative, and the total sum of the products will accordingly be either a positive or a negative quantity of which the magnitude will depend on the number of terms to be added. It follows therefore that the more the co-variant terms, the larger will be the numerator; and as the whole coefficient can never exceed ± 1, the closeness with which its value approaches ± 1 will be a measure of the closeness with which the phenomena under examination are connected by cause directly or inversely.

The Magnitude of the Phthisis Death-rate in various Countries and of its Variations.

Before considering the causes of the variations in the prevalence of phthisis it is desirable to have a picture of the extent both of the prevalence of the disease and of the variations in prevalence which have occurred over the forty years which are in question.

Tuberculosis still causes 11·3 per cent. of the total mortality in England and Wales, the greater part of this mortality occurring before old age and in the working years of life. Thus in 1903 of the total 58107 deaths from tuberculosis, 21 per cent. occurred at ages under 5, 7·7 per cent. at ages 5—15, 14·8 per cent. at ages 15—25, 47·1 per cent. at ages 25—55, and 9·4 per cent. at ages over 55. Pulmonary tuberculosis causes 69 per cent. of the total mortality from tuberculosis. With such a heavy present mortality from tuberculosis, and especially from phthisis, it is difficult to realise that in earlier years of registration of deaths in this country the recorded death-rate from tuberculosis was double its present magnitude. A similar decline has occurred in some but not in all other countries. Fig. 1 shows the course of the death-rate from phthisis in the United Kingdom and in some other countries since 1861–65.

Between 1866–70 and 1901–03 the death-rate of phthisis has declined 50 per cent. in England and Wales, 43 per cent. in Scotland, 54 per cent. in Massachusetts, while in Ireland it has increased 18 per cent. in the same period, and in Norway 46 per cent. between 1876–80 and 1901–03.

The percentage decline or increase in successive periods is shown in Table I:

TABLE I. *Percentage Reduction or Increase of Phthisis Death-rate in each Period*, 1861–65 *to* 1901–03.

	England and Wales	Scotland	Massachusetts	Ireland	Norway
1861–65 to 1866–70	– 4	+ 3	± 0	+2	—
1866–70 to 1871–75	– 9	– 4	– 5	+4	—
1871–75 to 1876–80	– 8	– 7	– 10	+5	—
1876–80 to 1881–85	– 10	– 8	+ 1	+4	+ 6
1881–85 to 1886–90	– 10	– 11	– 13	+2	+ 4
1886–90 to 1891–95	– 11	– 6	– 15	+½	+21
1891–95 to 1896–1900	– 10	– 5	– 14	–½	+18
1896–1900 to 1901–03	– 6	– 12[1]	– 16	+1	– 6

[1] To 1901–02.

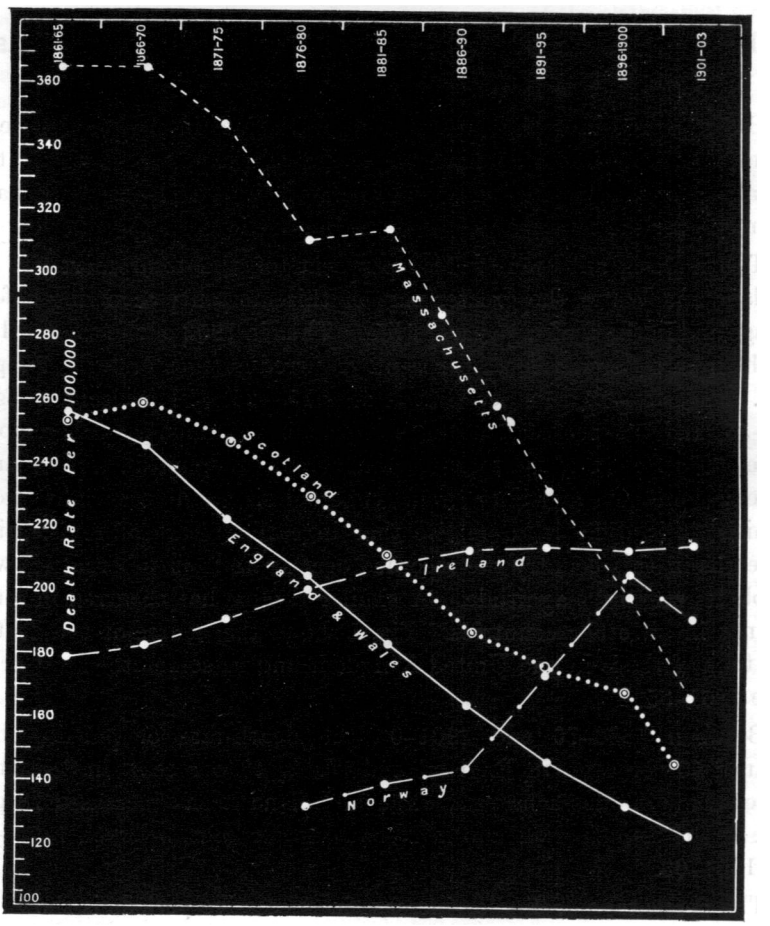

Fig. 1. Annual Death-rates from Pulmonary Phthisis per 100,000 of Population in England and Wales, Scotland, Ireland, Massachusetts, and Norway in quinquennial periods.

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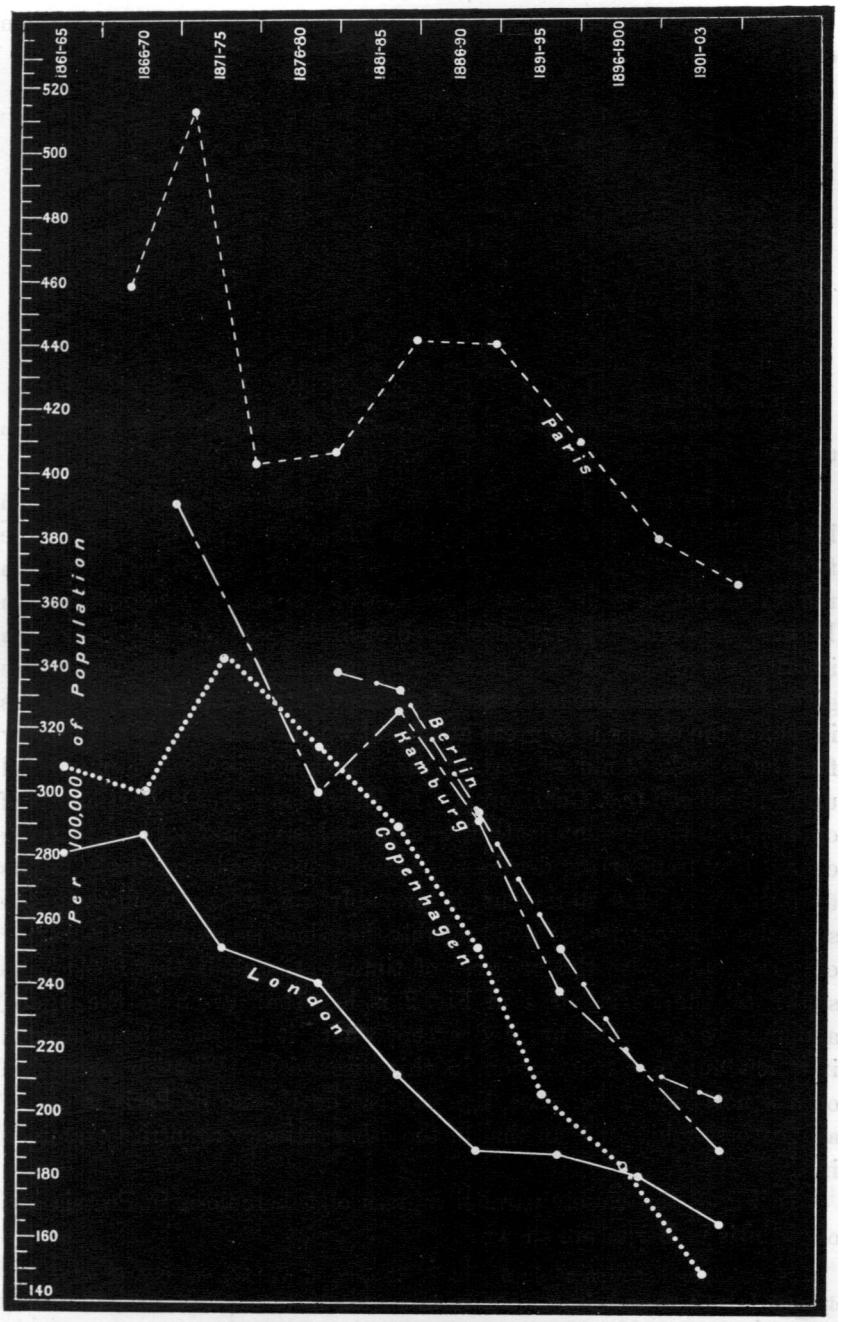

Fig. 2. Annual Death-rates from Pulmonary Phthisis per 100,000 of Population in London, Copenhagen, Hamburg, Berlin, and Paris, in quinquennial periods.

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In Fig. 2 and Table II, similar facts are shown for some European capitals.

TABLE II. *Percentage Reduction or Increase of Phthisis Death-rate in each Period,* 1866–70 *to* 1901–03.

	Paris	Berlin	Hamburg	Copenhagen	London
1866–70 to 71–75	—	—	—	+15	-12
1871–75 to 76–80	—	—	—	- 8	- 4
1876–80 to 81–85	+9	- 1[1]	—	- 8	-12
1881–85 to 86–90	±0	-11	-10	-13	-11
1886–90 to 91–95	-7	-14	-18	-18	- ½
1891–95 to 96–1900	-8	-15	- 9	-10	- 4
1896–1900 to 1901–03	-4[2]	- 4	-12	-19[3]	- 8

[1] 1877–80 to 81–85. [2] 1901–02.

[3] The Copenhagen figures are for periods earlier by one year than the other figures in the Table, *e.g.*, 1865–69, etc.

It will be noted that in Paris the death-rate from phthisis is much higher than that of any of the other European capitals of which the figures are given in Fig. 2. Professor Brouardel has thrown doubt on the French figures for phthisis because of the common euphemism in France of certifying phthisis as bronchitis. Dr Jacques Bertillon informs me that this is certainly true for some French towns, and he gives some remarkable instances of excessive death-rates from bronchitis in which the excess is so great at ages at which bronchitis is not usually fatal as to make it almost certain that much phthisis had been entered under this head (*e.g.* Cherbourg). In Paris, however, Dr Bertillon is of opinion that the present death-rate from phthisis would not be materially changed by transferring deaths registered as chronic bronchitis in adults to phthisis[1]. This statement is probably correct as applied to the statistics of recent years; and probably there has been increased accuracy of certification with the progress of time. It is likely that the decline shown by the Paris curve in Fig. 2 is less than given in the figure, and may be non-existent; and except where it is expressly mentioned it is left out of consideration in this discussion. Whether there has or has not been a decrease, the phthisis death-rate of Paris is out of all proportion higher than that of the other cities or countries examined in this paper.

In Fig. 3 the closely parallel courses of tuberculosis in Prussia and of phthisis in Berlin are shown.

[1] A critical examination of the figures for England of phthisis and "other respiratory diseases" shows no such large confusion in the death-returns (Newsholme: *Elements of Vital Statistics*, 3rd ed. pp. 238–239).

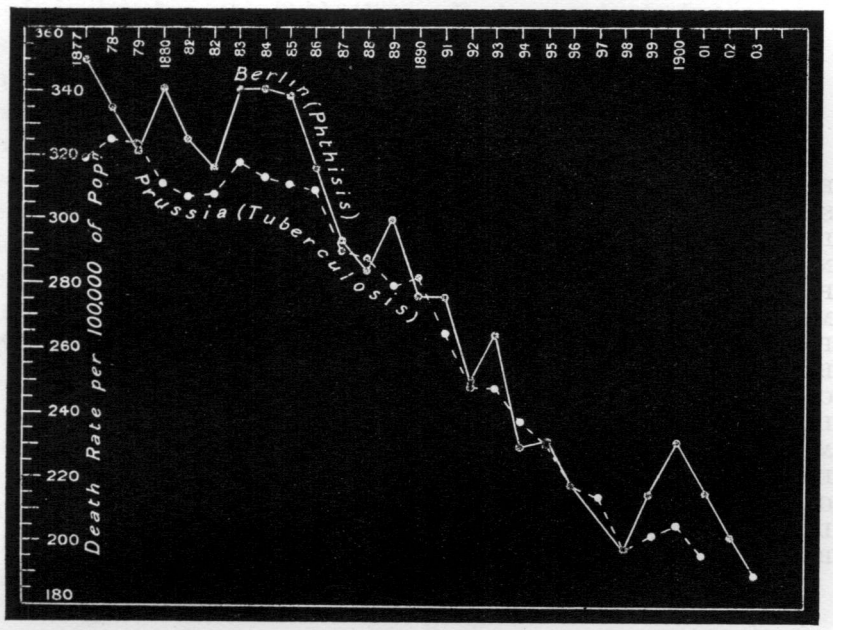

Fig. 3. Annual Death-rates from Tuberculosis in Prussia and from Pulmonary Phthisis in Berlin per 100,000 of Population in single years 1877–1903.

The Variations in the Death-rates from Phthisis and from other Diseases.

As a further preliminary it is desirable to compare the course of the phthisis death-rates with those of the death-rates from other diseases in the aggregate, in order to determine whether the changes in the phthisis-rates may have been due merely to the causes which have affected general death-rates.

In Table III the death-rates from phthisis and from all other causes in various countries and capital cities are given for 1881–85 and for 1901–03 or 1901–02. These more recent periods are taken for comparison, because in some instances earlier figures are unobtainable.

It will be noted that in all cases the general death-rate apart from phthisis has declined; the phthisis death-rate in all except Ireland and Norway. The highest decrease of general death-rate apart from phthisis is that of Norway, which shows a still higher increase of its phthisis-rate. It will be noted also that in every country and city in which a decrease of phthisis has been shown this decrease is greater

TABLE III.

	A Death-rate from all causes except Phthisis		B Death-rate from Phthisis		Percentage change in	
	1881–85	1901–03	1881–85	1901–03	A	B
England and Wales	17·97	14·94	1·83	1·23	– 17·0	– 32·7
Scotland	17·45	15·76	2·11	1·47	– 9·9	– 30·3
Ireland	15·90	15·45	2·08	2·15	– 2·8	+ 3·4
Norway	15·75	12·58	1·39	1·92	– 20·4	+ 38·1
Prussia	22·29	17·90	3·11[1]	1·93[1]	– 19·7	– 37·9
Massachusetts	16·68	14·77	3·14	1·67	– 11·5	– 46·8
Paris	19·99	14·15	4·41	3·65	– 29·3	– 17·2 (?)
Berlin	21·38	13·76	3·32	2·04	– 33·7	– 38·5
Copenhagen	19·38	14·81	2·89[2]	1·38	– 23·7	– 52·2
London	18·78	15·38	2·20	1·65	– 19·2	– 25·0
Manchester	18·76	16·34	2·42	2·01	– 13·1	– 16·9
Edinburgh	16·34	14·74	1·89	1·51	– 9·5	– 20·1
Glasgow	22·34	17·83[3]	3·14	1·68[3]	– 20·0	– 46·5
Dublin	24·25	23·02	3·55	3·28	– 5·2	– 7·6
Belfast	20·32	18·32	3·78	3·08	– 10·2	– 18·5

[1] Tuberculosis. [2] 1880–84. [3] 1901–04.

than that of the death-rate from all causes; and except in Dublin and Manchester the disparity between the two decreases is very great. Table IV, calculated from Dr Tatham's data for England and Wales, brings out the same point in greater detail, the facts being stated separately for the two sexes and for different ages.

TABLE IV. ENGLAND AND WALES.

Percentage Decline or Increase of Death-rate when the experience of 1861–70 *is compared with that of* 1896–1900.

	Males		Females	
At ages	General Death-rate *minus* Phthisis	Phthisis	General Death-rate *minus* Phthisis	Phthisis
0—	– 14	– 60	– 16	– 65
5—	– 49	– 67	– 45	– 58
10—	– 46	– 68	– 42	– 61
15—	– 32	– 59	– 40	– 63
20—	– 34	– 52	– 36	– 62
25—	– 28	– 43	– 29	– 58
35—	– 15	– 25	– 14	– 46
45—	– 1	– 17	0	– 44
55—	+ 6	– 19	+ 2	– 40
65—75	+ 3	– 24	0	– 36
All ages	– 13	– 38	– 14	– 54

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It is clear from this Table that in England, as in the instances in Table III to which reference has been made, the reduction of the phthisis death-rate is enormously greater than that of the general death-rate from all other causes; and the discrepancy is especially great at the working years of life in which phthisis causes its heaviest death-rate. If phthisis had only shared to an equal extent in the general reduction of mortality, a presumption would have arisen that the circumstances which have been operating to reduce the general death-rate such as higher wages, cheaper food and clothing, improved sanitation, and other allied influences, had been in themselves a sufficient explanation of the reduction of phthisis. The above figures show that this explanation is insufficient, however much these influences have contributed to the reduction, unless it be assumed that phthisis is far more susceptible to the operation of these influences than other diseases. For this assumption there is no evidence, and I am not aware that it has been made. The variation in the phthisis-rate must accordingly be taken to have involved co-variations in some phenomenon or group of phenomena which have had no material effect on the general death-rate.

The Factors of the Phthisis Death-rate.

There being no evidence of variation in the quality of the contagium of phthisis during the period under examination and some evidence against it, the explanation of the changes in its prevalence as measured by mortality must be sought in circumstances external to the contagium. These circumstances must have arisen through social and economical phenomena, which operate on the phthisis-rate by influencing either the spread of the contagium or the individual resistance to infection or in both ways. In examining these phenomena we must realise that they are more or less complex, and that the figures representing them have to be taken in the combinations in which they happen to have been recorded. It is possible to analyse them to some extent; but even their more elementary constituent phenomena for which data are available are still complex and often overlap. This does not affect the reasoning; but some confusion might arise if it were not realised that we are proceeding by way of an enumeration of compound phenomena, not of a classification of their elements.

The principal factors measuring the phenomena which reasonably can be thought material to the phthisis-rate are:

(1) Urbanisation.

(2) Housing, measured by overcrowding.

(3) Well-being, measured by
- (*a*) cost of wheat.
- (*b*) cost of total food.
- (*c*) total cost of living.
- (*d*) wages.
- (*e*) consumption of food.
- (*f*) pauperism.

(4) Sanitary education and special Sanatoria.

(5) Segregation of patients.

The phthisis death-rates with which the figures measuring these phenomena should be compared are not those of the same but for a somewhat later period, the interval representing the time taken for the effect of the phenomena to show itself. The average length of this interval cannot be stated with any certain approach to accuracy. It might be a quinquennium or more or less. Under these circumstances it is not certain that in a sufficiently long series of pairs a more accurate quantitative result would be secured by comparing the phenomena under investigation of one quinquennium or other period with the phthisis-rates of the next or next but one; and fortunately the run of the figures in the present inquiry is such that no material alteration is made by using the method of coetaneous comparison for the purposes in view. The point is worth noting, as in those cases where a ratio has to be formed between figures of certain phenomena and those of phthisis it might otherwise seem as if the ratio of phthisis of a given year to some other figure (as in segregation ratios) were being compared with the phthisis of the same year. Such ratios are in fact being compared with the phthisis of a slightly later period.

The preceding list does not include all the factors which at various times have been considered relevant to phthisis. Of the omissions the most important is "general sanitation." The definition of this term, so far as it specially relates to phthisis is given in a letter from Sir R. Thorne Thorne (1905, p. 40) which I have quoted elsewhere; and beyond the factors of improved housing and well-being, it includes broadly the provision of increased light and air in all buildings and streets, the suppression of dust in factories and workshops, and the drainage of the subsoil. With the exception of the last, I have been unable to discover figures for measuring directly this interesting group of phenomena. I have given reasons elsewhere (1901, p. 206) for believing that subsoil-

drainage is only a subsidiary factor in the reduction of phthisis, and for a similar opinion in regard to milk-supply (1905, p. 67); and the consideration of these points is therefore intentionally omitted from this paper. It is unfortunate that the factors of light and air-provision and of dust-prevention cannot be measured directly. It is certain that light which shows up dust and dirt, the chief sources of infection, must tend to restrain the prevalence of phthisis, and dust to augment it. There is an indirect expression of experience as to light and air contained in the figures of housing given hereafter, and an inference as to dust-prevention may be based on the evidence as to sanitary education; and if any predominating influence has been exercised by provision of light and air and by the suppression of dust, it will be reflected in the collation of the figures of the phthisis death-rate with those which exhibit the course of housing and of education as to the infectious nature of the disease and of its dust-borne character. In Great Britain for instance it will be found that much of the reduction of phthisis had occurred before systematic action had been well begun for the suppression of dust in factories and elsewhere.

TABLE V.

	Percentage of total population who were urban in		Phthisis Death-rate		Percentage increase in urbanisation	Relative amount of urban population in most recent period, that of England being taken as 100	Percentage reduction or increase of Phthisis	Phthisis Death-rate 1901-03, that of England = 100
	1861	1901	1866–70	1901–03				
England and Wales	63	77	2·45	1·23	22	100	−50	100
Scotland	52	70	2·59	1·48	35	91	−45	120
Ireland	20	31	1·82	2·15	55	40	+18	175
	1864	1895						
Prussia	30	41	3·20[1]	1·94[1]	37	53	−39[1]	?
	1865	1891						
France	29	38	4·57[2]	3·65[2]	31	48	? none	297
	1840	1890	Mass.					
United States	8	29	3·65	1·67	262	38	−50	136
	1865	1891						
Norway	16	21	1·32[3]	1·92	31	27	+46	156

[1] Between 1877–80 and 1901–03. [2] Paris.
[3] In 1876–80.

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Urbanisation.

Table V exhibits for certain countries the distribution of the population between town and country at or near the beginning and end of the period under review. The definition of "urban" varies somewhat in different countries, but in each country remains the same throughout the period under examination, so that the results are comparable. The corresponding phthisis-rates are included in the Table, and the changes in the death-rates are expressed as percentages of the earlier figures.

More recent data as to urbanisation are contained in the Table VI from Dr Shadwell's work (1905, Vol. II.).

TABLE VI. *Percentage of the population of great towns having over* 100,000 *inhabitants to the entire population of each country.*

England		Germany		United States	
1881	1901	1880	1900	1880	1900
31·6	35·0	7·2	16·2	14·6	18·8

The course of phthisis in towns is shown by the figures in Tables II and III so far as large cities are concerned. It will be noted that without exception the urban death-rates from phthisis are higher than the phthisis death-rates of the countries in which the cities are contained. In Berlin the death-rate from phthisis is higher than that from all forms of tuberculosis in Prussia (Fig. 3).

A more accurate means of studying the effect of urbanisation in increasing the phthisis death-rate is supplied by two valuable tables by Dr Tatham, published in the Registrar-General's Report (1904, pp. lv and lxxiii) from which the following Table is extracted and calculated. This Table deals with an estimated urban population of 18,262,173, including the chief industrial centres, and a rural population, including only a few unimportant towns and villages, of 4,327,835. The death-rates have been corrected for variations in the age and sex-distribution of the respective populations. No statistical correction can be made for the fact that the towns attract the robust and strong to work in them, while the weakly tend to remain in, and return to rural districts. If this could be done, the contrast between urban and rural death-rates would doubtless be greater than appears below.

TABLE VII. ENGLAND AND WALES.

Selected Urban and Rural Counties of the Registrar-General, 1898 to 1903.

Corrected Death-rates per 1,000 of Population.

	Males		Females	
	All causes except Phthisis	Phthisis	All causes except Phthisis	Phthisis
Urban Counties	18·4	1·66	17·5	1·11
Rural ,,	13·5	1·27	13·2	1·07
Proportional Figures[1] (Rural rate = 100).				
Urban Counties	137	131	133	104
Rural ,,	100	100	100	100

The figures in Tables III and V show conclusively that in the countries and during the period in question: (*a*) the conditions of urban life have invariably produced a substantially higher phthisis death-rate than those of rural life; and (*b*) the influence of urbanisation in favouring phthisis has been more than overcome by other influences in operation. In each country an enormous change has occurred both in the extent of urbanisation and in the phthisis death-rate; but so far from the changes having been proportional or even having differed only in amount, in every instance, with the exception of Ireland and Norway and the very doubtful instance of France, they have been in opposite directions. As a predominating influence on a national death-rate from phthisis urbanisation must therefore be dismissed entirely; and no better example could be given of the manner in which a powerful influence may be masked by others still more powerful. It must be noted that where decrease of phthisis has occurred in urban districts, this decrease has been greater than the reduction in the death-rate from all causes excluding phthisis. This has already been seen to be the case for each country as a whole, and it goes to show that in the urban as in the national statistics the reduction in the death-rate from phthisis has not been due to mere improvement in the general death-rate.

[1] It will be noticed that in the urban counties in the aggregate the death-rate from all causes excluding phthisis among males is 37 per cent., and among females 33 per cent., higher than in the rural counties, while the rate from phthisis is among males 31 per cent. higher, and among females only 4 per cent. higher in the urban than in the rural counties. Thus although all that is implied in the word "urbanisation" increases the death-rate from all causes other than phthisis with an approximate equality in the two sexes, it has had on the whole but little effect in increasing the female phthisis-rate in towns. The discussion of this phenomenon is not essential to the present paper, and out of consideration of space, I merely draw attention to it as a suggestive fact.

The influence of industrial occupations is doubtless a material factor in town life, and the urban phthisis death-rate, in so far as it is higher than the general phthisis death-rate, may be regarded as a fairly good index of the influence of industrial conditions on phthisis.

Housing: Overcrowding.

Table VIII gives information derived from the census reports of England and Wales for 1891 and 1901, as to the proportion of the population in the urban and rural parts of England living in tenements of different sizes.

TABLE VIII. ENGLAND AND WALES.

Percentage of the Total Population in each Group of Tenements.

	Urban Districts		Rural Districts	
Tenements containing	1891	1901	1891	1901
One Room	2·9	2·0	0·4	0·2
Two Rooms	9·4	7·4	5·6	3·9
Three ,,	11·5	10·3	10·1	8·1
Four ,,	22·4	21·2	26·3	24·0
Five or more Rooms	53·8	59·1	57·6	63·8
	100·0	100·0	100·0	100·0

With this experience should be considered the figures as to overcrowding, defined as occupation of each room in a dwelling on an average by more than two persons, which are given in Table IX.

TABLE IX. ENGLAND AND WALES.

Amount of overcrowding in 1891 *and* 1901 *in Urban and Rural Districts, stated as a percentage of the total population living in one to four-roomed tenements with more than two occupants per room.*

Tenements with	Urban Districts		Amount of overcrowding in 1901, that in 1891=100	Rural Districts		Amount of overcrowding in 1901, that in 1891=100
	1891	1901		1891	1901	
	(1)	(2)		(3)	(4)	
1 Room	1·61	0·95	60	0·25	0·09	36
2 Rooms	4·42	3·07	70	2·48	1·54	62
3 ,,	3·46	2·63	76	2·83	1·98	70
4 ,,	2·82	2·25	80	2·90	2·23	77

Putting these experiences together it appears that there was some improvement in respect of overcrowding between 1891 and 1901; and although at previous census enumerations corresponding information was not obtained, it is likely that the improvement has been progressive.

At the same time a marked difference is seen between urban and rural districts in respect both of size of dwellings and overcrowding in them. This difference is exactly in the same direction as the difference which has been already shown to exist between the urban and the rural phthisis death-rates of males.

Mr Matheson, Registrar-General for Ireland (1903), has analysed the experience of Ireland (Table X) from 1861 onwards, except in 1871, in which some differences of classification occurred. In this Table the population is divided among four classes of houses. The fourth class of house comprises chiefly houses of mud or other perishable materials, having only one room and window; the third class a rather better class of house having from two to four rooms and as many windows; the second class is equivalent to what would be considered a good farm house having five to nine rooms and windows; and the first class comprises all better houses.

TABLE X.

Percentage proportion of total families in the Urban and Rural parts of Ireland respectively who live in each of the following classes of houses.

Character of houses	Total no. of urban families	Urban housing				Total no. of rural families	Rural housing			
		1861	1881	1891	1901		1861	1881	1891	1901
1st class	247,477	25·8	23·7	22·9	21·7	880,823	3·3	4·7	5·4	6·5
2nd ,,	254,922	54·2	62·3	66·0	69·9	740,152	33·0	40·6	48·6	55·7
3rd ,,	252,112	18·3	13·2	10·7	8·2	680,001	53·5	49·4	43·0	36·9
4th ,,	277,509	1·7	·8	·4	·2	622,747	10·2	5·3	3·0	·9
		100·0	100·0	100·0	100·0		100·0	100·0	100·0	100·0

Mr Matheson's conclusion is that "the material improvement in the housing of the people of Ireland since 1841 is very satisfactory but that there is still much to be accomplished."

Comparing Ireland with England and Scotland, Mr Matheson finds that in 1901 in England 3·6 per cent., in Ireland 8·7 per cent., and in Scotland 17·5 per cent., of the total dwellings consisted of only one room; further that the percentage of the total population living in these one-roomed tenements and having five or more persons in each tenement was 0·15 in England, 1·78 in Ireland, and 3·27 in Scotland. Thus Scotland has more than double the proportion of one-roomed tenements that Ireland has, and in nearly twice as many of these the number of occupants exceeds five.

The conditions of Paris in respect of housing are bad and its death-rate from phthisis is probably nearly stationary. At the census of 1901

the percentage number of families in different sized dwellings was as follows (Bertillon, 1901, p. 121):

	No. of rooms					
	1	2	3	4	5	Over 5
Out of every 100 families the number occupying the different sizes of dwellings was	26·7	30·1	21·8	10·0	4·3	7·1

Over one-fourth of the families occupied only one room, nearly one-third occupied only two rooms, and more than three-fourths of the families lived in three rooms or less.

In each building (Grundstück) in Stadt Berlin there were the following number of inhabitants in different years (Hirschberg, 1904, p. 97):

1867	1875	1885	1895	1900
51·3	57·9	66·9	72·0	77·0

In 1900 each building contained on an average 19·2 dwellings, which is equivalent to four persons for each dwelling.

A more complete comparison of housing conditions at different periods in Berlin is given by Table XI (1901, vol. I.).

TABLE XI. BERLIN.

The number of inhabited Dwellings or Tenements out of every 100 *Dwellings or Tenements of every kind which comprised one or a larger number of Rooms with stoves.*

	Number of Rooms					
Year	0	1	2	3	4	Four & over
1861	—	50	26	12	5	7
1864	3	49	26	12	5	5
1867	1	49	27	11	6	6
1871	2	53	24	10	5	6
1875	2	51	25	10	5	7
1880	1	50	26	11	5	7
1885	1	50	27	11	5	6
1890	1	50	27	11	5	6
1895	1	50	27	11	5	6

The conditions so far as concerns the proportion of the total population of Berlin living in tenements comprising only one room have in fact remained stationary. One-half of the dwellings of Berlin consist, and during the period of inquiry have consisted of one room, and one-fourth similarly consist of two rooms. The average size of the block buildings in which the population chiefly live has become larger.

In regard to the condition of New York, Dr Hermann Biggs (1903–4, p. 191) states:

"There has been a more rapid fall in the tuberculosis death-rate in New York City than in any great city in the world, and this notwithstanding the fact that the conditions in many respects are much more unfavourable, because of the very dense population in the great tenement-house districts of the City, and the large element of foreign-born population. It should be remembered that in no city of the world is there such a density of population as exists in many of the wards of the Borough of Manhattan." As illustrating Dr Biggs' observation it may be stated that the phthisis death-rate was 4·27 in 1881 and 2·40 in 1903, a fall of 44 per cent.; the corresponding rates in London being 2·18 and 1·60 and its fall 26 per cent.

The relative conditions of England, Germany and U.S.A. in 1900, are more clearly shown in the following figures:

Number of persons per inhabited house.

England	5·2	Germany	8·9	U.S.A.	5·3
Lancashire	4·7	Saxony	11·7	Massachusetts	6·3
Yorks. W. R.	4.5	Rhineland	8·5	Pennsylvania	5·5
Staffordshire	4·9	Brandenburg (without Berlin)	10·4	Rhode Island	6·7

Comparing towns we have the following results:

England		Germany	U.S.A.
London	7·9	Berlin 46·6	New York 13·7
9 partly commercial and partly industrial towns	4·6	24·2	7·6

The preceding figures compiled by Dr Shadwell (1905, vol. II. p. 198) are summarised by him in the following sentence: "in England the industrial classes live in separate houses or cottages, in Germany they live in barracks, and in America in larger houses which are shared by more than one family." He adds: "we have nothing to compare in England to the house famine which prevails in Germany."

The outcome of these figures is to show improvement of housing associated with

(*a*) decrease of phthisis (England, Scotland),

(*b*) increase of phthisis (Ireland);

and heavily and increasingly congested housing associated with

(*a*) high and probably stationary phthisis death-rate (Paris),

(*b*) great decrease of phthisis death-rate which is still high (Germany, Berlin, New York).

It is highly probable that neither the association between improved housing and reduced phthisis in Great Britain, nor that between very congested housing and high phthisis-rates in the foreign countries quoted is accidental. In view of the known pathology of the disease, no circumstance could be more calculated to exercise a uniformly adverse influence in this disease than overcrowding. Clearly however abnormally high congestion of housing has been unable in most of the above countries to prevent immense decrease in the phthisis-rate; and marked improvement in housing in Ireland, which has brought it well above the level of Scotland in regard to average number of rooms per dwelling for the very poor has not sufficed to prevent the rise of the phthisis-rate. Overcrowding must therefore be classed with urbanisation as a factor of proved effect on the phthisis-rate, which usually in the period under observation has been unable to overcome counteracting influences.

The Influence of Well-Being.

The influence of well-being on the phthisis death-rate has never been questioned, and in the judgment of many authorities it is the most important factor. No factor more deserves careful attention, and in the following pages I have endeavoured to trace separately the course of as many of its elements as possible. In considering these it must be remembered that we are dealing not with the therapeutic effect of these elements on phthisical patients on whom they are applied under exceptional conditions and in artificial excess, but with their prophylactic influence taken in normal quantities and in the circumstances of ordinary life. Much clinical experience appears to indicate that "over-feeding," especially with proteids, has a marked beneficial effect in the treatment of phthisis; and although, so far as I know, there is no record of its value apart from open-air treatment, and the latter may therefore possibly be partially responsible for the beneficial results ascribed to the former, there is considerable probability that the high diet has been at least an important factor in the therapeutic effect. It is of course quite possible that food and especially proteid food exerts, when taken in health in ordinary amounts, a prophylactic influence against phthisis similar to the therapeutic effect on the consumptive when given in much larger amounts under open-air conditions. On existing evidence, however, it is equally possible that a certain minimum excess is necessary for producing the predominant therapeutic effect which has

been remarked; and a similar excess may conceivably be necessary to the production of a predominant prophylaxis. There is, so far as I know, no evidence to enable one to decide between these possibilities.

In using the figures which express the extent to which the countries under comparison have enjoyed the several elements of well-being, no correction is made for the varying good which different persons and possibly different nations will have made of equal amounts of commodities. The absence of such correction in the present inquiry is without serious importance. The nation in whom thrift or superior efficiency in utilising their means might have been supposed to have produced the decrease in phthisis is Germany; and if it were in fact shown that Germans had such superiority over the other nations in question, then the bare comparison of their means with those of less thrifty nations would be inconclusive. In the present discussion however the inclusion of France and Norway, whose figures for phthisis are very different from those of Germany and whose reputation for thrift is equally high, avoids the difficulty.

Well-being: Price of Wheat.

Table XII shows the course of wheat-prices during a series of years in certain countries, together with the death-rates from phthisis; and Table XIII shows the proportional prices and death-rates relative to

TABLE XII.

	Average price of wheat in pence per imperial gallon				Death-rate per 100,000 of population from Phthisis in						
	United Kingdom	France	Germany	United States	England & Wales	London	Scotland	Ireland	Paris	Tuber-culosis in Prussia	
1841–50	640	550	494	466	—	—	—	—	—	—	
1851–60	656	617	624	608	—	—	—	—	—	—	
1861–70	613	603 (1861-69)	560	746	256 245	280 286	253 259	178[1] 182	— 451[2]	— —	1861-65 1866–70
1871–75	656	664	615	674	222	251	248	190	612[3]	—	
1876–80	570	612	552	536	204	240	230	200	402[4] 406	317[5]	
1881–85	481	529	481	458	183	211	211	208	441	312	
1886–90	377	503	455	365	164	188	188	213	440	290	
1891–95	335	476	438	299	146	187	176	214	410	246	
1896–1900	343	459	423	343	132	180	168	213	379	207	
1901–02	326	440	426	328	123	165[6]	147[7]	215	365[7]	193	

[1] 1864–65. [2] 1865–69. [3] 1870–71. [4] 1872–75.
[5] 1877–80. [6] 1901–04. [7] 1901–02.

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the figures for 1901–02. In Fig. 4 the course of the prices of wheat and of the phthisis death-rates for a series of years is shown.

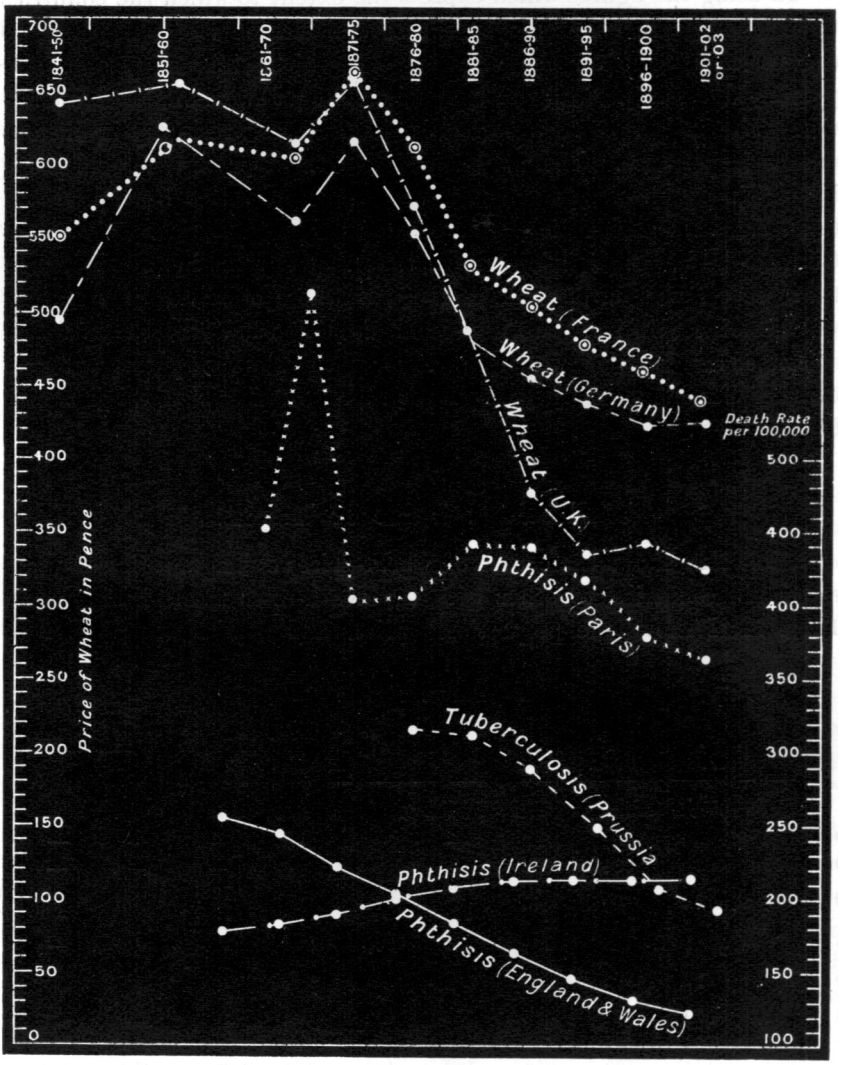

Fig. 4. Prices of Wheat in France, Germany and the United Kingdom, and Phthisis Death-rates in Paris, England and Wales and Ireland, and Tuberculosis Death-rates in Prussia per 100,000 of Population.

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TABLE XIII. *Relative figures for Wheat and Phthisis.*

	Wheat				Phthisis							
	United Kingdom	France	Germany	United States	England & Wales	London	Scotland	Ireland	Paris	Massa-chusetts	Tuber-culosis in Prussia	
1841–50	197	125	116	143	—	—	—	—	—	—	—	
1851–60	201	140	147	186	229 209	206 169	162	—	—	246 233	—	1851–55 1856–60
1861–70	188	137	132	228	208 200	170 173	172 176	83 85	124 168	219 201	—	1861–65 1866–70
1871–75	201	151	145	206	181	152	169	89	110	207	—	
1876–80	175	139	130	164	166	146	157	93	111	186	165	
1881–85	148	120	113	140	149	128	144	97	121	189	163	
1886–90	116	114	107	112	134	114	128	99	121	164	145	
1891–95	103	108	103	91	119	113	120	99	112	140	121	
1896–1900	105	104	100	105	108	109	114	99	104	119	104	
1901–02	100	100	100	100	100	100	100	100	100	100	100	
	326	440	426	328	123	165	147	215	365	167	193	
	Absolute price in years taken as standard.				Death-rates from Phthisis or Tuberculosis in 1901–02 or 1901–03.							

In Figs. 5 to 8 the facts of Table XIII are shown diagrammatically. By the use of proportional figures the curves of prices and phthisis-rates are reduced to the same scale, and can be exactly compared. The curves are carried back beyond the period at which the phthisis-rates can be entirely trusted, in order to give a wider sweep for the comparison of past and present economic conditions, but inferences in regard to phthisis are only made from the rates from 1866–70 onwards.

Fig. 5 shows the phthisis and wheat curves for the United Kingdom. As previously shown by Sir Hugh Beevor, there is a fairly close relationship in Great Britain between the phthisis and wheat curves. There is one important exception to this statement. Prior to 1875, a great reduction of phthisis had occurred, without any cheapening of wheat.

In Ireland, which has shared the benefits of cheaper bread, there is obviously no relation between the price of wheat and the death-rate from phthisis. It may be stated further that the price of potatoes per cwt. in the ten years 1864–1873 averaged 53*d.*; in the ten years 1894–1903, it averaged 40*d.* These are the means of the extreme values given in the Annual Reports of the Registrar-General for Ireland.

Fig. 6 shows the course of the phthisis curve for Paris and the wheat curve for France. As already stated it is probable that in Paris the phthisis-rate has declined little, if at all. Even if we accept the

official figures of declining phthisis, no correspondence is visible between the official figures of variations of phthisis-rate and price of wheat. The proportional phthisis-rate increased from 111 in 1876–80, to 121 in 1881–85, while the proportional price of wheat fell from 173 to 146. Between 1891–95 and 1901–2 the price of wheat has been almost stationary, and the recorded death-rate has fallen from 112 to 100.

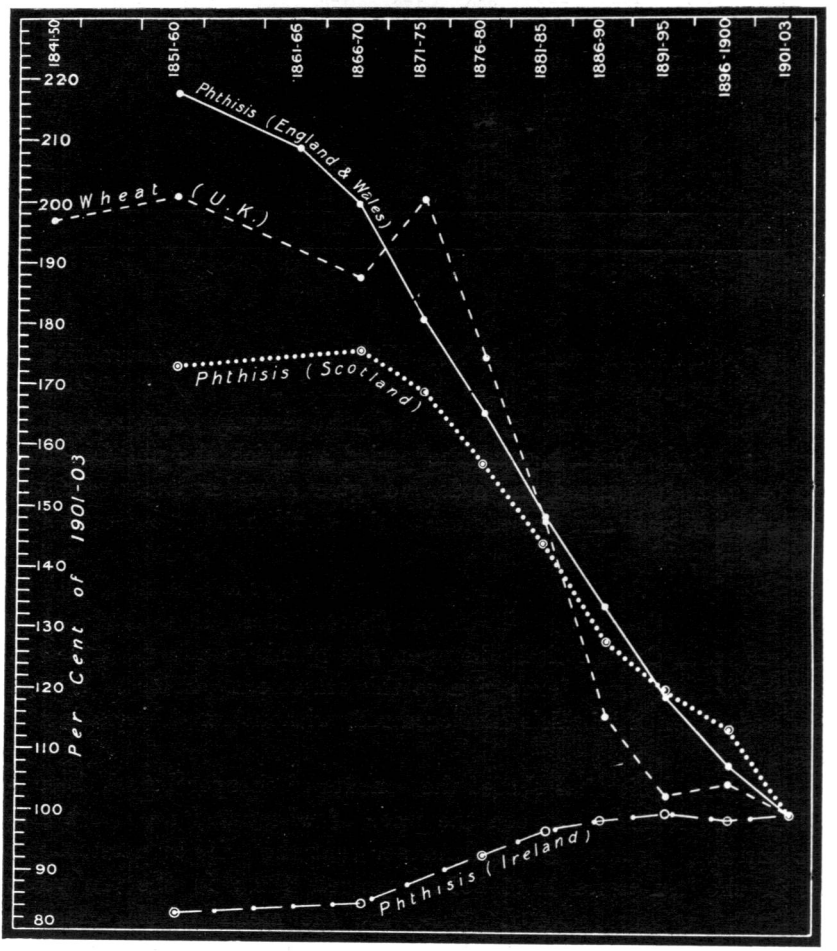

Fig. 5. Proportional death-rates from Phthisis in England and Wales, Scotland and Ireland, 1851–60 to 1901–03, and Price of Wheat in the United Kingdom, 1840–50 to 1901–02.

Note.—The curves in Figs. 5 to 11 do not show actual prices and death-rates, but only the percentage changes in them.

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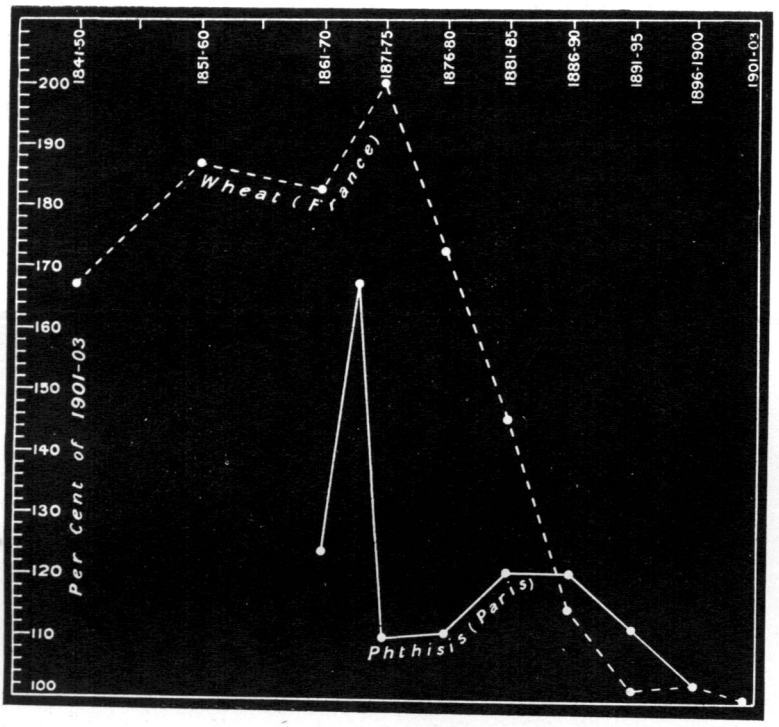

Fig. 6. Proportional Death-rates from Phthisis in Paris 1861–69 to 1901–02, and Price of Wheat 1841–50 to 1901–02.

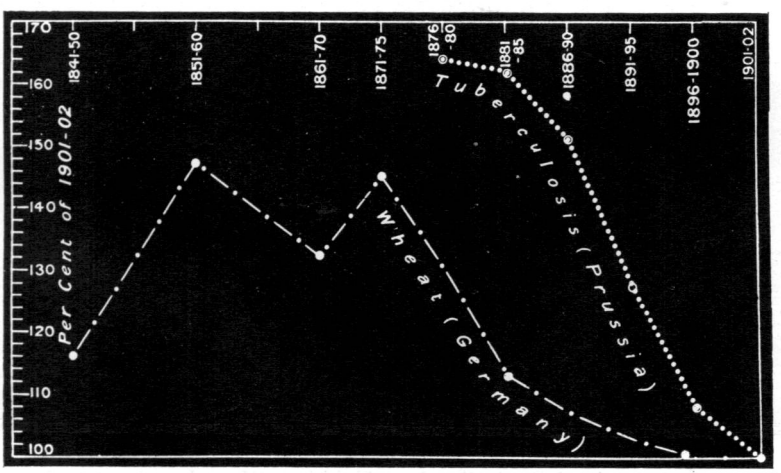

Fig. 7. Proportional Death-rates from Tuberculosis in Prussia 1877–80 to 1901–02, and Price of Wheat 1841–50 to 1901–02.

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The form in which figures are available compels comparison between Germany and Prussia, and also the substitution of tuberculosis for phthisis. Between 1876–80 and 1886–90, tuberculosis declined only from 164 in 1876–80 and 162 in 1881–85 to 151, while wheat declined from 130 to 107; while between 1886–90 and the present time, the decline of wheat has only been from 107 to 100, that of tuberculosis from 151 in 1886–90 and 128 in 1891–95 to 100.

In the United States where the margin of wages is great, and where

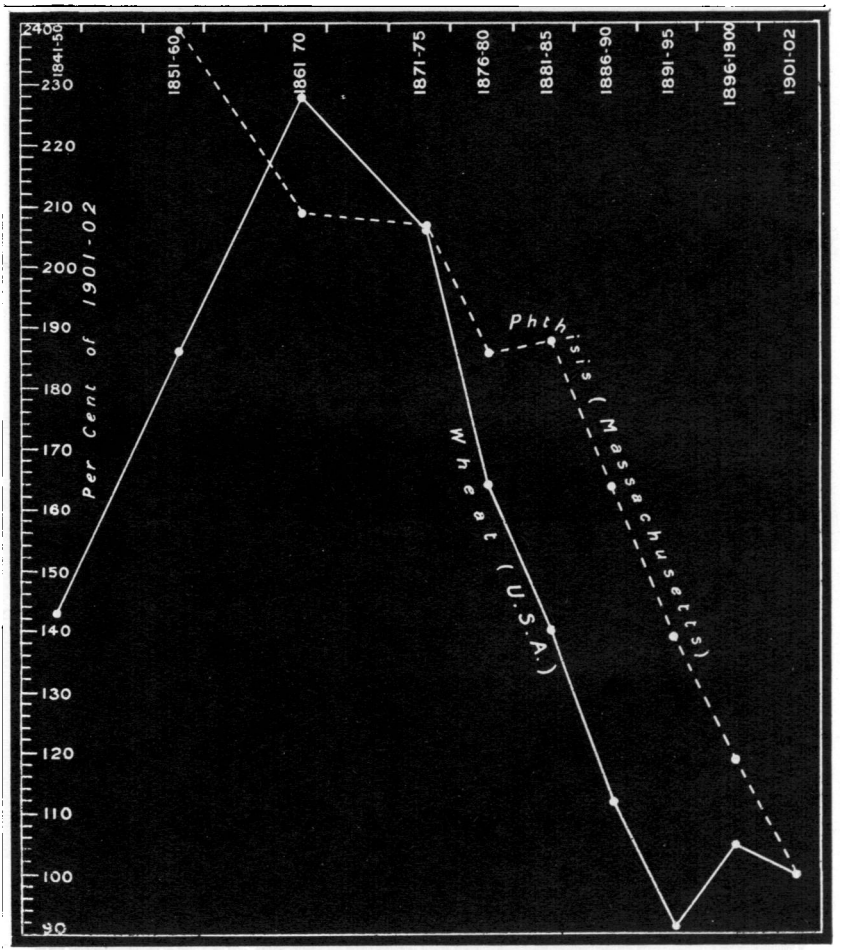

Fig. 8. Proportional Death-rates from Phthisis in Massachusetts 1851–55 to 1901–02, and Price of Wheat 1841–50 to 1901–02.

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the price of wheat cannot be of such vital importance, the two curves are fairly correspondent up to 1890, but then diverge widely: a rise of wheat from 91 to 100 since 1891–95 having been associated with a fall in phthisis from 139 to 100 in 1891–95, and 119 in 1895–1900.

The data given above for the course of phthisis and of wheat prices are connected by the following coefficients of correlation.

Price of Wheat and Phthisis Death-rates.

	Period of observation	Coefficient of correlation
England and Wales	1866—1902	+ ·90
Scotland	1868—1902	+ ·87
Ireland	1866—1902	− ·80
Prussia	1877—1901	+ ·55
Paris	1866—1902	+ ·31

Expressed in words these figures summarise the preceding tables and curves by showing a close co-variation between phthisis-rates and wheat-prices in England and Scotland; moderate and poor co-variation in Prussia and France respectively; and considerable inverse co-variation in Ireland.

Well-being: Cost of Total Food.

The data for a review of total cost of food in certain countries from 1877 are furnished in Government Blue Books recently issued (1903, pp. 215 and 224) "Index numbers" are employed in the following table based on the retail prices collected by the Labour Department of the Board of Trade, of bread, flour, potatoes, beef, mutton, bacon, butter, tea and sugar; value being attached to each of these articles in accordance with the annual amounts spent by households in the purchase of the various articles.

TABLE XIV. *Relative figures for total cost of Food and Phthisis.*

	Total cost of food		Phthisis in			
	United Kingdom	Germany	England & Wales	Scotland	Ireland	Tuberculosis in Prussia
1877–80	135	112	166	157	93	165
1881–85	126	105	149	144	97	163
1886–90	102	99	134	128	99	145
1891–95	98	103	119	120	99	121
1896–1900	94	99	108	114	99	104
1901	100	100	100	100	100	100

(The cost of food and the phthisis death-rates respectively in 1901 are stated as 100; the other figures being given in proportion to the values for 1901.)

These figures are given in Table XV. They are also shown in Figs. 9 and 10.

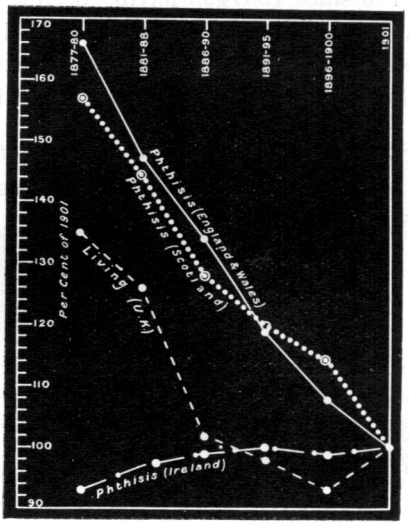

Fig. 9. Proportional Death-rates from Phthisis in England and Wales, Scotland and Ireland, and Cost of Food 1877-80 to 1901.

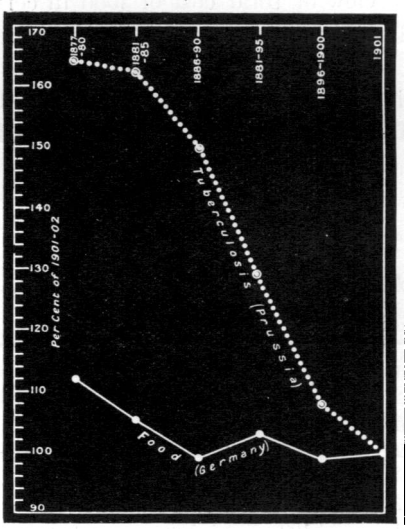

Fig. 10. Proportional Death-rates from Tuberculosis in Prussia, and Cost of Food in Germany 1877–80 to 1901.

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It will be noted that in and since 1886–90, the price of food has remained almost stationary; during the same period the phthisis death-rate in England has fallen in the proportion of 134 to 100, and of Scotland in the proportion of 128 to 100. In Ireland a rise of phthisis has been accompanied by a marked decrease in the cost of food. The course of the Irish phthisis death-rate is seen in Fig. 1 page 314. Ireland has experienced the same cheapening of food as Great Britain.

In Germany (Fig. 10) between 1877 and 1886, during which time the death-rate from tuberculosis in Prussia was stationary, the total cost of food fell from 115 to 95, or from 112 to 105 in the consecutive periods 1877–80 and 1881–85. On the other hand, in the period 1886–90, in which the cost of food was as low as in 1901, the death-rate from tuberculosis was 50 per cent. higher.

The correlation-coefficients which connect these data are as follows:

Total Cost of Food and Phthisis Death-rates.

	Period of observation	Coefficient of correlation
England and Wales	1877—1901	+ ·90
Scotland	1877—1901	+ ·88
Ireland	1877—1901	− ·49
Germany	1877—1901	+ ·42

These figures show close co-variation between the phthisis-rate and the total cost of food in England and Wales and in Scotland; poor co-variation in Germany; and some inverse co-variation in Ireland.

Well-being: Total Cost of Living.

The figures enabling the relationship between total cost of living and the phthisis death-rate to be stated, are derived from the 2nd Fiscal Blue Book (1904, p. 33). They refer to workmen's expenditure in London and large towns in Great Britain, the relative price in 1900 being in each case stated as 100. The proportional costs in 1881–85 and in 1900 respectively were: for food 133 and 100, for rent 89 and 100, for clothing 105 and 100, for fuel and clothing together 75 and 100; and for all the above four chief items of workmen's expenditure 116 and 100[1]. The cost of living in the United Kingdom has therefore considerably declined, as compared with what it was in 1881.

Fig. 11 shows the course of the phthisis death-rate, and the total cost of living in England and Wales.

[1] The proportional weights adopted in giving the data in Fig. 11 have been: food, 7; rent, 2; clothing, 2; fuel and light, 1, of a total expenditure on these terms of 12.

The cost of living in England, therefore, has been fairly uniform during the last 15 years; during approximately the same period the phthisis death-rate has declined in the proportion of 134 to 100.

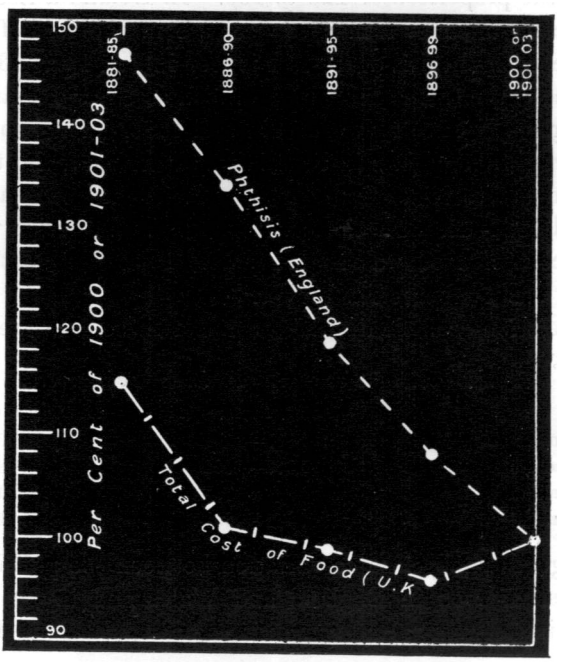

Fig. 11. Proportional Death-rates from Phthisis in England, and Total Cost of Living 1881–85 to 1901–03.

There are independent reasons for believing that in Ireland the prices of total food, clothing, fuel and rent, have varied in the same directions and approximately to the same extent as in Great Britain; and on this assumption the coefficient of correlation has been calculated for Ireland as well as for England and Scotland.

Total cost of living and Phthisis Death-rates.

	Period of observation	Coefficient of correlation
England and Wales	1880—1903	+ ·76
Scotland	1880—1902	+ ·76
Ireland	1880—1903	− ·24

Thus when to cost of food is added that of clothing and fuel and rent, which are only less important than the cost of food, the direct co-variation with the phthisis-rate becomes less marked in Great

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Britain, and some inverse co-variation continues to be shown in the experience of Ireland.

Well-being: Wages.

It may be suggested that the lack of correspondence between cost of living and death-rate from phthisis may be due to the disturbing effect of changes in wages. Unfortunately, exact comparison of wages can only be made from official data for workmen engaged in skilled trades and for agricultural labourers. It is probable, however, that these wages give some clue to the corresponding wages of other workmen.

Table XV compares the recent experience of different countries.

TABLE XV. *Comparison of Rates of Wages in Skilled Trades.*

	United Kingdom	France	Germany	United States
Number of quotations of wages on which the following results are based	470	248	184	141
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Mean weekly wages for 15 skilled trades: 1. Capital cities ...	42 0	36 0	24 0	75 0
2. Other cities and towns	36 0	22 10	22 6	69 4
Percentage Comparison (United Kingdom = 100): 1. Capital cities ...	100	86	57	179
2. Other cities and towns	100	63	63	193

British money wages are the highest in Europe, and the margin over the cost of living is probably the greatest in Europe.

The Board of Trade's Report gives the following *comparison of average family incomes:*

United Kingdom	France	Germany	United States
100	83	69	123

If, in the language of the above Report, we "split the difference," arrived at by two methods, we may conclude that "the average level of industrial wages in the United States is not far from $1\frac{1}{2}$ times that in the United Kingdom.... In the same way, we might, without great error, take the average for Germany as $\frac{2}{3}$, and for France $\frac{3}{4}$ of that which prevails in the United Kingdom."

The preceding official data are confirmed by facts independently collected by Dr Shadwell (1905, vol. II. pp. 81 and 91). He gives the following ratios for wages of unskilled labourers in the three countries:

England	Germany	United States
100	78·6	142·8

and he believes that these figures more nearly represent the actual state of matters than the preceding from Cd 1761 which give the

ratios for skilled workman as 100, 57, and 179 in the capitals, and 100, 63, and 193 in other towns.

Dr Shadwell also quotes the following ratios from the *Bulletin of the American Bureau of Labour*, No 54, Sept. 1904.

TABLE XVI. *Relative Values of Wages in Three Countries.*

	England	Germany	United States
Blacksmiths	100	71	169
Boiler makers	100	65	165
Machinists	100	78	161
General Labourers	100	78	164

For the textile industries Dr Shadwell gives the following ratios:

Cotton Weavers	100	93	121
Woollen Weavers	100	77	177
Do. not including women weavers in U.S.A.	100	80	135

The above statement of rates of wages takes no account of length of current hours of labour. Speaking generally, they are shortest in the United Kingdom, next shortest in the U.S.A., France coming next, and Germany having the longest hours of labour as well as the lowest wages. Dr Shadwell on the same point (1905, vol. II. p. 123) says "the hours of labour are shorter in England that in Germany or America. This is true both in general and in particular." He adds that "in the chief manufacturing industries the normal working day is from 1 to 1½ hours longer in Germany than in England and the difference constantly tends to decrease." Hours of labour need correcting, were it practicable, for output. The general impression is that English work less actively than American workmen; but this is incorrect if facts vouched for by Sir John Brunner are not exceptional. He states that in the alkali industry the comparative number of men employed for an equal output is 110 in America, 131 in Germany and 100 in England. English works have an 8 hours shift, German a 12 hours shift.

On the whole these facts seem to show that there is no sufficient material for making a correction in respect of severity of work, and that no substantial fallacy is likely to be introduced by omitting it.

The only comparison of wages practicable between different parts of the United Kingdom is for agricultural labourers. The data from this comparison are derived from an important report by Mr Wilson Fox, C. B. (Cd 2376, p. 5). He gives the following table:

TABLE XVII. *Average earnings per week (including the value of all allowances in kind) of able-bodied male adult ordinary agricultural labourers.*

	1898	1902	Percentage increase between 1898 & 1902
	s. *d.*	*s.* *d.*	
England	16 9	17 5	4·0
Wales	16 6	17 7	6·6
Scotland	18 2	19 5	6·9
Ireland	10 2	10 9	5·7

On p. 5 of the same report Mr Fox remarks: "there is no doubt that the position of a farm labourer in Ireland is not so good as in other parts of the United Kingdom, but it may be added that he gets his house and fuel cheaper, and frequently has the opportunity of renting land on which he grows potatoes and keeps pigs, goats, and poultry."

Mr Wilson Fox's report enables a comparison to be made for agricultural labourers over a long series of years in the three parts of the United Kingdom. The following Table from his report illustrates the course of wages on certain sample farms between 1850 and 1903. The rates of wages are expressed in percentages, the year 1900 being taken to represent 100 :—

TABLE XVIII.

	1850	1860	1870	1880	1890	1900	1903
England and Wales (69 farms)	64	76	82	91	90	100	101
Scotland (6 farms)	50	60	71	85	91	100	103
Ireland (10 farms)	56	63	71	81	90	100	101

Mr Wilson Fox, C.B., in answer to an inquiry, kindly writes me the following statement (May 16, 1906): "As stated on p. 220 of the Report" (*On the Wages, etc. of Agricultural Labourers in the United Kingdom*) "the employers who furnished these records were asked if the allowances in kind, given in addition to cash wages, had varied during the period of years for which wages were quoted, and you will see from the notes appended to the various records that on the whole there was very little variation, the tendency being to increase the extras as well as the rates of wages. It seems safe to assume, therefore, that there has been no diminution in the social well-being of farm-labourers in Ireland, and that the steady rise in wages shown on p. 137 is not overstated."

Comparing the past with the present, there has been great increase of wages all round (Tables XVIII, XIX and XX).

The greatest increase has been in Germany, the least in the United States. It should be noted that these ratios indicate the course of wages in each country, but not the absolute amounts. The ratios of different countries are not comparable with each other, and the country showing the greatest increase of wages (Germany) still pays its workmen

a lower average wage than that in other countries. Unfortunately, the comparison for Germany does not extend back beyond 1886. Between 1886–90 and 1891–95 the death-rate from tuberculosis fell 15 per cent., while wages rose 5 per cent.

TABLE XIX. *Ratio of Average Rates of Wages in Different Countries (exclusive in all Cases of Agriculture)* (Cd 1761, p. 275). *Wages in* 1900 = 100.

	United Kingdom	France	Germany	United States
Years	Principal Groups of Trades	Mean of Skilled Trades	Groups of Principal Trades under Imperial Insurance Scheme	Average of all Trades
1881—1885	83·4	86·9	—	90·5
1886—1890	84·6	—	80·9	93·3
1891—1895	89·4	—	84·9	95·8
1896—1899	91·7	96·0 (1896)	92·7	96·0
1900	**100·0**	**100·0**	**100·0**	**100·0**

Table XX gives some data as to the course of wages in Norway (1905).

TABLE XX. *Wages in Norway.*

	Wages in Kroner				
A. *Rural Communes.*	1885	1890	1895	1900	Percentage increase between 1885 & 1900
Annual Wages of Domestic Servants — Male	163	169	180	218	34
Annual Wages of Domestic Servants — Female	73	77	85	100	37
Daily Wages, average of all the industries (23) enumerated in the tables	1·81	1·82	1·95	2·25	24
B. *Towns.*					
Annual Wages of Domestic Servants — Men	224	239	265	303	35
Annual Wages of Domestic Servants — Women	85	91	100	130	53
Daily Wages, average of all the industries (55) enumerated in the tables	2·17	2·33	2·46	2·83	31
Monthly Wages, average of all the occupations (8) enumerated in the tables	—	71	70	83	18

Wages have increased between 1885 and 1900 in various industries from 24 to 53 per cent. Between 1895 and 1900 there has been some increase in the price of butcher's meat and of milk as shown by figures not here reproduced, but the price of all cereals has remained about stationary. As fish is the staple animal food, the price of meat is of relatively small importance.

It appears therefore that in Germany and Ireland wages lower than the British are associated with a higher phthisis-rate, while in the United States much higher wages are associated with a much higher

phthisis-rate. In Great Britain and the United States rise of wages has accompanied decrease of phthisis; in France probably no such correspondence has appeared; in Ireland considerable increase of wages has been associated with some increase of phthisis; in Norway considerable increase of wages has been accompanied by a great increase in phthisis.

Well-being: Amounts of Foods Consumed.

Table XXI gives the data for an approximate statement of the total amount of certain foods consumed per head in different countries.

The data are derived from official sources except those for meat (Cd 1761, p. 219).

TABLE XXI. *Annual Consumption in Pounds per Capita.*

	United Kingdom	France	Germany	Austria	Belgium	Ireland	U.S.A.
Wheat (and Flour as Grain)	350	473	200	—	—	—	278
Rye (and Flour as Grain)	6	77	325	—	—	—	20
Total Wheat and Rye	356	550	525	—	—	—	294[1]
Sugar	78·07	26·08	27·01	—	—	—	68·7
Tea	6·16	0·05	0·13	—	—	—	1·14
Coffee	0·76	4·79	6·63	—	—	—	10·60
Meat	126 England & Wales	70	75 Prussia	60	56	40	?
Phthisis Death-rate per 1,000	1881 1901	1881 1901	1881 1901	1881 1901	1881 1901	1881 1901	1881 1901
	1·83 1·27	4·11[2] 3·71[2]	3·08[3] 1·94[3]	3·84 3·34	1·88 1·35	1·95 2·15	

[1] In the U.S.A. considerable quantities of maize are retained for consumption.
[2] Paris only. [3] Tuberculosis.

For France I am able to add in Table XXII a statement of the relative amounts of different foods and luxuries consumed per head of population in successive periods (Littler, 1903, p. 161) and from these

TABLE XXII. *Relative Amount of Consumption of certain articles of Food &c. in France* (1863–67 = 100).

	Tea & Coffee	Cocoa	Sugar	Wheat	Potatoes	Tobacco
1863–67	100	100	100	100	100	100
1873–77	119	153	106	108	119	102
1878–82	149	186	135	124	109	110
1883–87	169	213	170	124	123	117
1888–92	170	233	178	124	133	117
1893–97	180	260	173	120	142	118
1898–1902	210	306	187	128	152	123

statements it will be seen that although there has been a steady increase under all these heads, and a marked increase in the consumption of meat, there has so far as can be judged been no corresponding decrease and it is doubtful if any decrease has occurred in the death-rate from phthisis.

The agricultural censuses of 1862, 1882, and 1892 gave also the amount of meat consumed per head in urban and rural France (Meredith, 1905, p. 175).

TABLE XXIII. *Consumption of Meat, in kilogrs, per head of Population.*

	Urban	Rural	France
1862	53·6	18·6	25·9
1882	64·6	21·9	33·1
1892	58·1	26·3	35·6

No uniform correspondence is to be found between the figures of food-consumption and those of phthisis. England with the lowest phthisis-rate has by far the highest consumption of meat, though not of other foods; and Belgium, with substantially the same phthisis-rate and the same decrease as England in the period under examination, consumes less meat than any country except Ireland, and less than half the amount consumed in England. France with a large and steadily increasing consumption of meat and of other foods, has, judging by Paris, the largest phthisis death-rate with no probable signs of improvement.

Well-being: Pauperism.

This inquiry has hitherto dealt with the experience of various countries in regard to the positive elements of well-being. It remains to see to what extent these results can be checked by figures expressing the absence of well-being. The nature of the returns only allows an examination of the figures in the countries of the United Kingdom, using for this purpose the poor-law returns. Before doing so, it is desirable to realise what figures of pauperism really indicate. Pauperism is officially-relieved poverty; and poverty itself, while most often due to absence of means, may also arise from the unskilful, injudicious, or mischievous use of means. Thriftlessness, sloth and intemperance all contribute their share to the figures of pauperism, side by side with the greater share which arises through no such communal or individual fault; and the conditions to which poverty leads, such as protracted exposure to infection, insufficient nutrition, and ignorance, work in a

vicious circle with the conditions that cause it, till it is difficult or impossible to distinguish those elements of poverty which represent destitution and would be relieved by the provision of ampler means, from those which are of an origin independent of material supplies and would persist even in a community which had no economic deficiencies. Poverty therefore is itself an eminently complex phenomenon, not to be remedied by any single set of measures; and if there were figures of actual poverty, they would not in themselves suffice to indicate the nature and extent of the causes from which the poverty arose nor of the steps which would be necessary to remove them. In fact however we have not figures of poverty, but only of pauperism, *i.e.* of State-relieved poverty. The amount of pauperism depends obviously not alone on the extent of poverty, but also on the test or standard by which the scale of relief is determined; and a given amount of poverty will beyond doubt yield very different figures of pauperism at various epochs and in various districts according to the scale of relief which happens to be applied. These considerations need to be remembered when pauperism is brought into line with the elements of well-being and when an attempt is made to bring its complex phenomena into relation with the phthisis experience. It will be seen shortly that in the United Kingdom during the period of observation there has been considerable correspondence between the variations of phthisis and those of pauperism; and this correspondence is taken as a sufficient reason for using the figures of total pauperism for the purposes of this paper as indices of the total amounts of phthisis when the actual phthisis figures cannot be had. It must not however be taken as a reason for regarding the variations in pauperism as an explanation of the variations in the prevalence of phthisis. It may show that within the bundle of phenomena which constitute pauperism such an explanation may be found; but until it has been ascertained which individual element or elements of the bundle contain the explanation, to explain the figures of phthisis by those of pauperism is for any practical purpose to explain *ignotum per ignotius.*

In considering the experience of Great Britain it must be remembered that about 1870 there was a vigorous and largely successful movement for insisting on the "house-test" for relief, and the sudden drop of total pauperism about this date and during the subsequent decade arose largely from this cause (Fig. 12). The experience of Ireland has been even more striking, because in the opposite direction to that of England and Scotland. In Ireland as shown in Fig. 15 a rigid system in which indoor relief was almost alone given has been superseded by a

largely outdoor system. As in the England of former times, this has been associated with a great increase of official pauperism; and apart from the facts which independently make it improbable that this increase of official pauperism is due to increase of privation in this very poor

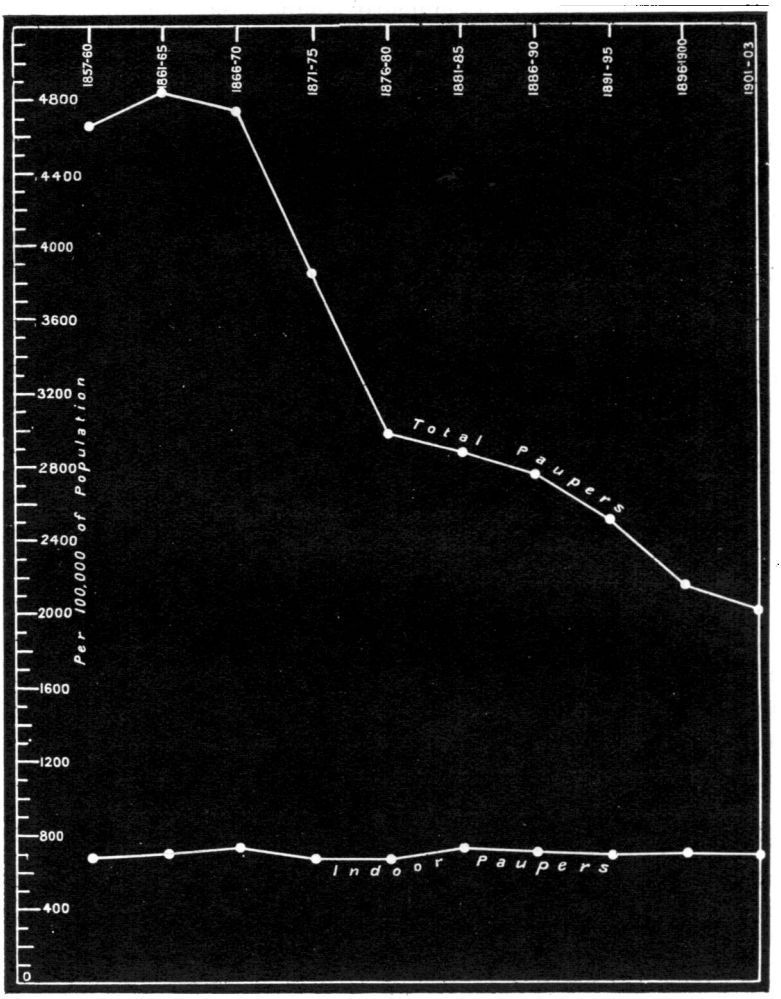

Fig. 12. England and Wales.—Average number of Paupers relieved each year in the Periods 1857–60 to 1901–03 per 100,000 of Population.

NOTE.—In this and in Figures 13–15, the vertical space between the curves representing total and indoor paupers respectively indicates the number of outdoor paupers.

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country, such a sweeping change in administration must have produced an increased number of paupers for a given amount of destitution.

Unfortunately there are no figures of pauperism for foreign countries suitable for comparison with our own; and it is therefore desirable to examine those of the United Kingdom with some minuteness. The course of pauperism in each country of the United Kingdom and in London is shown in Figs. 12 to 15. The curve of total pauperism in

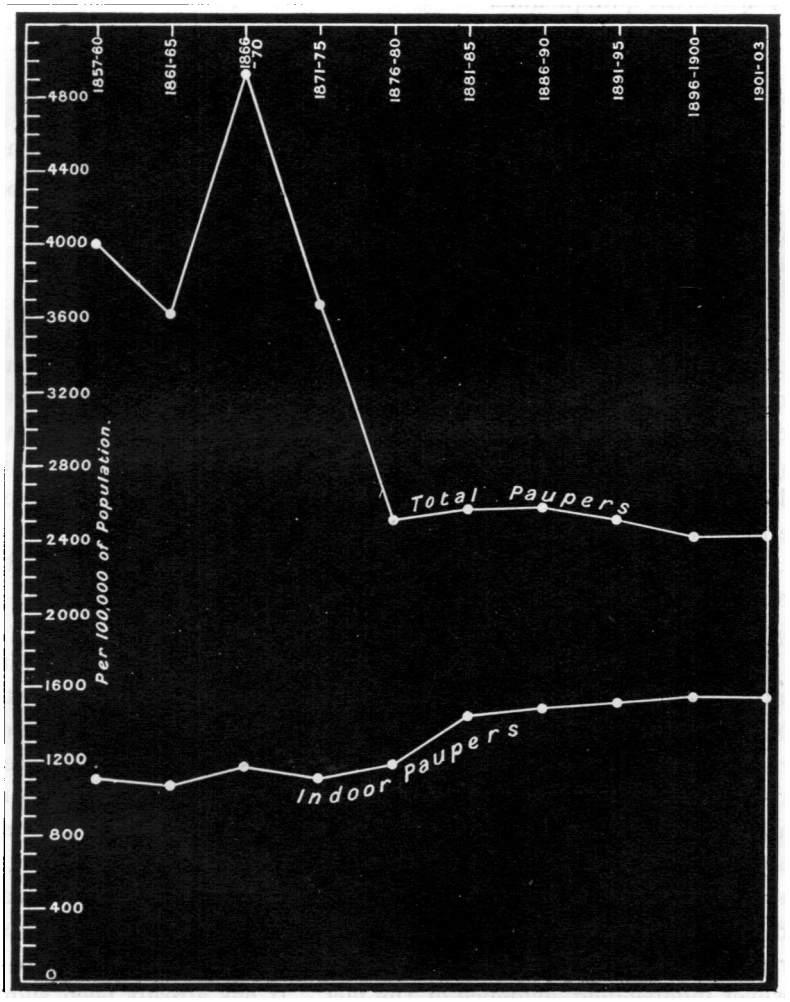

Fig. 13. London.—Average number of Paupers relieved each year in the Periods 1857–60 to 1901–03 per 100,000 of Population.

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each instance should be compared with the corresponding curves of phthisis death-rates (Figs. 1 and 2, pp. 313–315).

It will be seen that if allowance be made for the reduction in the relief figures introduced about 1870 by the more rigid insistence on the "house-test," there is a remarkable correspondence between the curves of phthisis and of total pauperism. The following table shows the corresponding percentage declines of each for the whole period and for its constituent quinquennia.

TABLE XXIV. ENGLAND AND WALES.

Percentage Declines of Rates of Phthisis and of Pauperism.

	1866–70 to 1901–03	1866–70 to 1871–75	1871–75 to 1876–80	1876–80 to 1881–85	1881–85 to 1886–90	1886–90 to 1891–95	1891–95 to 1896–1900	1896–1900 to 1901–03
Phthisis Death-rate	49·8	9·4	8·1	10·2	10·3	10·9	9·6	6·8
Total Pauperism-rate	52·3	17·7	22·1	3·7	4·2	9·5	5·4	6·0

The total decreases for the entire period—49·8 per cent. for phthisis and 52·3 per cent. for pauperism,—are surprisingly close without any allowance at all. Individual quinquennia show much greater discrepancies; but when it is remembered that phthisis has a long course and may have a still longer period of latency, and that any administrative influence is likely to operate slowly, a close quantitative relation between the figures for short periods cannot be expected.

The correspondence in London and Scotland when allowance has been made for changes in administration, though not so close as in England and Wales, is nevertheless close.

In Ireland if we make the necessary allowance for the great administrative increase of outdoor relief shown in Fig. 15, and compare the subsequent curve of pauperism with that of phthisis (Fig. 1), a close correspondence is seen. The case of Ireland is of particular interest. Its experience shows no decline of phthisis; and it is a much poorer country than either England or Scotland, and its inhabitants are probably less well nourished than those of Great Britain. It would be unsafe to assume on historical grounds alone that the lack of exact parallelism between the earlier parts of the phthisis and pauperism curves is due merely or mainly to administrative change. There is however independent evidence of the fact. It has already been shown (pp. 325, 331–332, 336–338, 341) that the economic condition of Ireland has not become worse, and that so far as can be measured by the tests

already given it has improved. Agricultural labourers in 1881 formed 46·0 and in 1901 44·3 per cent. of the total male population of Ireland over 10 years of age; and between 1870 and 1900 the wages of these labourers had increased 42 per cent. Food has become cheaper, rents are low, overcrowding has declined, and is less marked than in Scotland (p. 325). It seems clear therefore that poverty has been growing less in Ireland during the period of observation, and if this be so, we must infer that the increase of pauperism has been due to altered administration and not to increase of destitution.

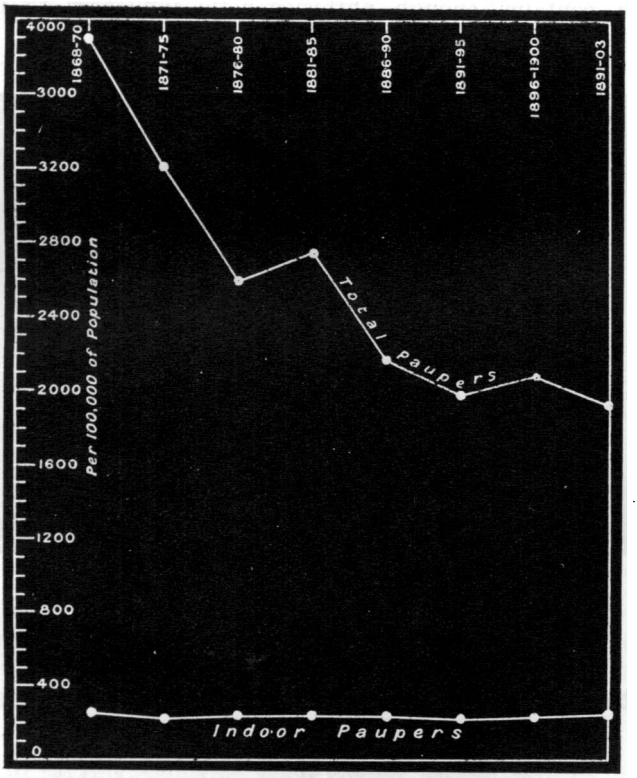

Fig. 14. Scotland.—Average number of Paupers relieved each year in the Periods 1857–60 to 1901–03 per 100,000 of Population.

The figures of pauperism and of phthisis for the entire period are connected by the following correlation-coefficients:

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Correlation between Total Pauperism and Phthisis.

	Period	Coefficient of correlation
England and Wales	1866—1903	+ ·89
Scotland	1868—1902	+ ·90
Ireland	1866—1902	+ ·83

These figures summarise a close co-variation in each of these countries between phthisis death-rate and total pauperism. This result is what would be expected from the pathology of the disease. However minutely pauperism is analysed, each element which is disclosed is such as would favour an increased phthisis-rate. In each of these countries, therefore, the figures of pauperism confirm the *a priori* expectation that pauperism contains enough phthisiogenetic influences to make its figures vary closely with the figures of phthisis.

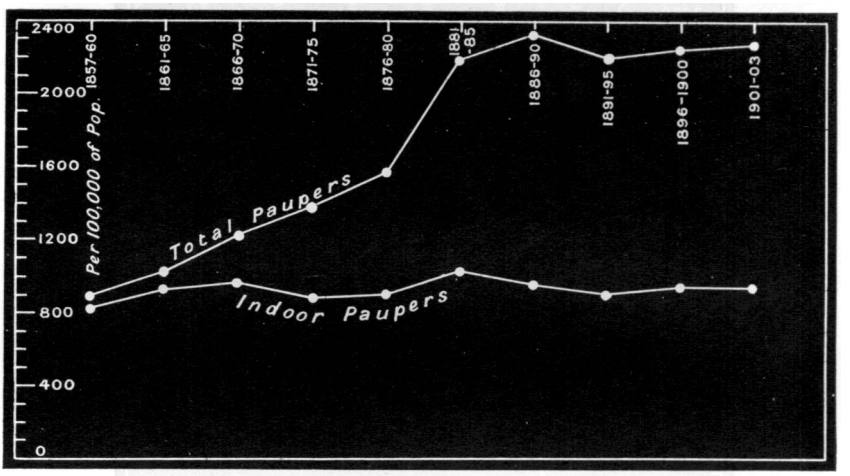

Fig. 15. Ireland.—Average number of Paupers relieved each year in the Periods 1857–60 to 1901–03 per 100,000 of Population.

Education of the Public and Direct Preventive Measures.

Koch teaches very strongly on *a priori* grounds that direct infection has a preponderating influence on the prevalence of phthisis; and the facts reviewed in this paper will be found to lead by another road to the same conclusion. In a passage quoted by Dr Bulstrode (1903, II. p. 208), Koch says: "The fact that tuberculosis has considerably diminished in almost all civilised States of late is attributable to the circumstances that knowledge of the contagious character of tuberculosis has been

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more and more widely disseminated, and that caution in intercourse with consumptives has increased more and more in consequence."

Koch's first paper describing the discovery of the tubercle bacillus was published in 1882, his more complete results in 1884. Prior to this period, it cannot be said that any suspicion of infectivity had a notable influence on medical or public action. Had Koch's contention on this point been correct, the chief reduction of phthisis should have occurred since 1884. In Germany, this has been so: in Great Britain it is otherwise.

Table XXV gives the quinquennial percentage decline of the phthisis-rate before and since 1885 in England and Wales and in Scotland (the last period is two years).

TABLE XXV. *Percentage Decline in Phthisis Death-rate between*

	1866–70 and 1871–75	1871–75 and 1876–80	1876–80 and 1881–85	1881–85 and 1886–90	1886–90 and 1891–95	1891–95 and 1896–1900	1896–1900 and 1901–04
England & Wales	9·4	8·1	10·2	10·3	10·9	9·6	6·8
Scotland	3·5	7·2	8·0	10·9	6·3	4·5	13·1 (1901–02)

The rate of decline was substantially as great before as since the infectivity of phthisis became generally known to the medical profession. In recent years the rate of decline has diminished. In Scotland the rate of decline has been more irregular.

The international figures are interesting in the same connection (see Table XXVI).

TABLE XXVI. *Percentage Decline of Phthisis or Tuberculosis Death-rate between*

	1881–85 and 1886–90	1886–90 and 1891–95	1891–95 and 1896–1900	1896–1900 and 1901–02, or 1903, or 1904
Switzerland	2	8	3	1½
Prussia	7	15	16	7
Paris[1]	0	5	7	3

[1] Figures of doubtful accuracy.

Thus in several countries a slackening of the rate of decline of the phthisis death-rate is noticeable in recent years. It will not be contended by the most ardent anti-contagionist that education and consequent precautions have caused this diminution in the rate of decline. Neither, on the other hand, is it possible to show that the extremely limited action taken on directly preventive lines has so far

impressed itself on national statistics. As the matter stands, there is no evidence of a causal connection sufficiently large to be traceable between the decline of the phthisis death-rates and the progress of education in hygienic matters.

Nor conversely can it be imagined that similar educative influences have been entirely absent from Ireland and Norway in which an increase, or from France in which probably no decline, of phthisis has occurred. The action taken in consequence of knowledge of the infectiousness of phthisis has doubtless varied greatly in different countries and in different parts of the same country. In Germany alone can treatment in special sanatoria have any claim to the decline which has occurred, as the use of these elsewhere has until a few years ago been on a very small scale compared with the total amount of disease. Sanatorium

TABLE XXVII. SANATORIA IN GERMANY.

	Public	Private	Prussia
Year opened	Number of beds	Number of beds	Tuberculosis Death-rate per 1000
1854	—	300	—
1873	—	120	—
1875	—	80	—
1876	—	114	—
1881	—	100	307
1885	—	12	311
1887	—	100	290
1889	—	205	279
1892	194	—	248
1893	103	—	248
1894	—	275	237
1895	196	—	231
1896	195	—	217
1897	504	—	214
1898	958	135	197
1899	590	119	202
1900	817	—	205
1901	794	66	196
1902	811	—	—

treatment, furthermore, has, with the same exception, been employed chiefly for well-to-do patients who from the public health standpoint need it least. Even in Germany the sanatorium treatment of phthisis was as will be seen in the following Table on a very small scale until after 1892, when the first popular sanatoria were opened (Santoliquido, 1903, VII. p. 45); and these institutions cannot have played more than an insignificant part in the great decline of the death-rate from tuberculosis which

took place between 1886–89 and 1890–93. Of the great value of sanatoria in the treatment of phthisis there can be no doubt; of their possibly even greater educational value everyone is convinced; but their main utility lies in the future.

The Infectivity and Latent Period of Phthisis.

Before passing to consider the influence of segregation on the prevention of phthisis, it is convenient to summarise at this point the evidence as to personal infection and the duration of the latent period which follows infection. This evidence, although the facts underlying it are not without effect in considering the factors of phthisis already discussed, is obviously of special importance in relation to segregation. I do not propose to recapitulate the evidence pointing to the conclusion that the chief source of infection in human phthisis is the consumptive human patient. On this point, notwithstanding Von Behring's views already mentioned as to the predominance of infection from cows' milk, the vast majority of pathologists and hygienists are agreed. My own opinion to the same effect has been formed not only on the general considerations to be found in the literature of the subject, but also on the personal investigation of a very large number of notified cases. There appears to be a complete absence of evidence as to the relative infectivity of the expectoration from early and late cases of phthisis. It may, I think, be safely assumed that the infectivity varies roughly with the amount of sputum, with the added consideration that in advanced disease the patient is less able to control the hygienic disposal of his sputum.

The literature as to the duration of latency of tuberculosis is scanty, though it is generally agreed that it may vary greatly. The point is one of great importance in determining the source of an individual's infection, and is important in considering figures which extend over a series of years. The principal data may be stated shortly.

It has been experimentally shown in the rabbit and the guinea-pig that a small dose of the virus tends to limitation of the disease. Generalised disease may, as is usually the case, follow the invasion of other parts of the body from such a localised focus, or possibly—though certainly less often—from large immediate doses of virus. It is well known that a local tubercular lesion may become encapsulated and remain so for years without producing manifest clinical symptoms.

From such a focus,—most often in the post-bronchial glands—widespread infection may occur at the end of many years. It is the discovery of such old foci that has led Mott to state that in most of the autopsies on tubercular patients in metropolitan lunatic asylums the infection had been received before the patient entered the asylum. Autopsies in hospitals on patients not dying of tuberculosis are well known to show evidence of old tubercular lesions in 50 per cent. or more of the total cases. Evidently, then, tubercular lesions commonly do exist for a long time in the body without producing marked symptoms, and such lesions often are the cause of active tuberculosis. Clinical evidence points in the same direction. Thus Dr Austin Flint (1882, II. p. 617) draws attention to the now well known fact "that in a certain proportion of cases this disease (phthisis) ends favourably irrespective of any appreciable extrinsic agencies." He gives particulars of 670 private patients watched by him for several years, in 44 of which the disease ended in recovery, and in 31 remained non-progressive, and many others were untraced. He goes on to point out that self-limitation of the disease is the rule in the majority even of the fatal cases of phthisis. "The disease as a rule advances not by a continuous progress but by a series of successive invasions separated by variable intervals. After each invasion or as it has been termed, eruption of tuberculosis, there is a temporary self-limitation of the disease."

The evidence obtained in the investigation of notified cases of phthisis is in my experience commonly of the same character. Although many patients give a shorter history of symptoms, in many others—and in my opinion probably in the majority when careful investigation is made—a history of former attacks of winter cough or slight haemoptysis or pleurisy is obtainable, from which the patient has recovered. These earlier attacks of pleurisy or haemoptysis cannot be regarded as representing the beginning of the patient's infection, but as secondary phenomena caused by earlier infection which has spread from the bronchial glands or elsewhere.

If the above considerations express the material facts, it follows that a present active phthisis very commonly dates many years back in the patient's history, not only when recognisable symptoms of tuberculosis have occurred in the patient's past history, but often when, even without such history, there has been protracted exposure to infection in early life. These facts indicate the necessity for eliminating so far as practicable the vitiating effect of migration in local inquiries respecting relative amounts of phthisis.

The Measures of Institutional Segregation.

The theoretically exact measure of the extent of institutional segregation is, of course, the ratio of the number of days of institutional phthisical sickness to the number of days of total phthisical sickness, *i.e.*:

$$\frac{\text{No. of days of phthisis sickness in institutions}}{\text{No. of days of total phthisis sickness}}.$$

The figures required for the denominator of this ratio evidently cannot be obtained. The total number of cases of phthisis in the community is unknown, as there is no general notification of the disease, and even were such notification enforced, it would necessarily under present conditions be extremely incomplete. Failing a list of total cases of phthisis, two measures of the amount of phthisis present themselves: total deaths from phthisis, and total number of paupers. There is no evidence of any marked change in the type of disease in phthisis, and the number of deaths from it forms therefore a satisfactory index of total phthisis, when multiplied by a coefficient measuring the average proportion of cases to deaths. The total pauper population probably is the nearest approach to a satisfactory index of phthisis apart from figures of mortality. The pauper population is that part of the population which is the last to be reached by any ameliorating influences tending to control phthisis, and which will therefore as a body have a higher average infectivity, and yield figures of which the variations will more closely resemble those of the phthisical sick, than would the general population. The figures for total relief of pauperism may thus be taken to represent on some scale those of total phthisis cases; and the correctness of this assumption at least for the United Kingdom has already been seen in the close co-variation of the two sets of figures over a long period (p. 350).

Turning to the numerator we also lack an accurate index, except in those towns for which the number of days of institutional treatment of phthisis has been specially obtained (pp. 367 and 371), and we must, as for the denominator, fall back on other measures for the amount of institutionally treated phthisis. Thus we may ascertain

(*a*) the number of cases of, or deaths from, phthisis in institutions;

(*b*) the total deaths from all causes in institutions, as phthisis always forms a large part of these;

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(*c*) the total patients from all diseases treated in institutions. This cannot be ascertained for all hospitals, and in England it resolves itself into accepting the total number of indoor paupers as the nearest approach, as indoor paupers comprise by far the largest number of consumptives who are institutionally treated.

The scale on which each of these quantities represents either the total number of consumptives or of segregated consumptives is different in each case; and the value of the ratio between any of the expressions measuring the numerator and any of those measuring the denominator will represent the amount of segregation on a different scale. On their several scales these ratios represent with more or less approximate accuracy the ratio of total to institutionally treated phthisis, and may be conveniently called *segregation ratios.* The ratio chosen in each instance is determined by the available material, and the variety of forms of ratio given below is necessary because of the varying forms in which the material is available in different countries.

The ratios which have been suggested by the form of the figures available in the various countries under review are

$$\frac{\text{No. of institutional deaths from phthisis}}{\text{No. of total deaths from phthisis}},$$

$$\frac{\text{No. of institutional deaths from all causes}}{\text{No. of total deaths from all causes}},$$

$$\frac{\text{No. of indoor paupers}}{\text{No. of total paupers}},$$

and

$$\frac{\text{No. of cases of } \left\{\begin{matrix}\text{phthisis}\\ \text{tuberculosis}\end{matrix}\right\} \text{ institutionally treated}}{\text{No. of total deaths from } \left\{\begin{matrix}\text{phthisis}\\ \text{tuberculosis}\end{matrix}\right\}}.$$

From their constitution it will be seen that, to such extent as the material used for any ratio represents the same phenomenon, similar results are to be expected, whichever form of ratio is chosen. There are however variable factors affecting the material. Thus the figures of hospital segregation give no information as to the number of days of treatment, and while they tell approximately how many people were segregated, they do not tell the average duration of such segregation. They also leave us without information as to the proportion of phthisical cases which have been treated domestically. Where, again, total phthisis cases are represented by deaths from all causes or by figures of pauperism, the actual propor-

tion in which phthisis enters into these phenomena is not defined strictly, nor is it strictly constant. These circumstances call for caution in the adoption of a particular ratio for given sets of figures, and make it desirable to verify on samples the approximate accuracy with which it represents what it stands for. This has been done so far as the information obtainable has allowed. It will be seen that the results obtained by applying different ratios to the experience of the same country and period are usually, though not invariably, in good agreement; and where this is not the case, fortunately other data have been available to explain the discrepancy and enable a more correct segregation-ratio to be formed.

In a previous paper on this subject (1905, p. 69) I used chiefly the ratio of indoor to total pauperism as the measure of segregation of phthisis. In this ratio the total paupers in the community are taken as a fairly accurate index of total phthisis on one scale; while the figures for indoor relief represent on another scale the cases of phthisis which are segregated. The ratio of indoor to total relief becomes, then, on some other scale a correct measure of the extent of segregation, if the number of days of sickness could be assumed as equal for each class. This assumption would probably be incorrect; but to such extent as consumptives admitted to indoor relief are, in fact, treated longer than the average of other paupers, the error would be to exhibit the extent of segregation as being less than it really is, and for the present purpose the figures may therefore be used with safety.

As has been pointed out previously the phthisis-rates with which these ratios should be compared are not those for the same but for a somewhat later period, the interval representing the time taken for the effect of segregation to show itself. For the present purpose this comparison can in any sufficiently long series of years be made with the phthisis figures of the same year, not because the phthisis is affected immediately by simultaneous changes in other phenomena, but because the numerical difference between closely consecutive phthisis figures in the present material happens to be small.

Institutional Treatment: United Kingdom.

The form in which usually it is easiest to obtain the statistical material for a segregation ratio is the ratio of institutional treatment measured by the proportion of deaths in institutions to total deaths in the community. In some instances published or communicated information has allowed the use of the special phthisis figures.

Table XXVIII gives a measure of the gross inmates of institutions in the three countries of the United Kingdom at the date of the last census.

TABLE XXVIII. *Proportion per Million of the Total Population who at the Time of the Census Enumeration in* 1901 *were in Public Institutions* (1901, p. 186).

	United Kingdom	England and Wales	Scotland	Ireland
Workhouses (including Workhouse Infirmaries and Schools)	6,390	6,415	2,958	9,654
Hospitals	1,308	1,292	1,775	960
Lunatic Asylums	2,889	2,787	2,630	3,891

Thus, in 1901, 1 in 69 of the total population of Ireland, 1 in 96 of the total population of England and Wales, and 1 in 137 of the total population of Scotland, were occupants of one or other of the three above-named classes of institutions. In 1891 the corresponding proportions were: Ireland, 1 in 82; England and Wales, 1 in 107; and Scotland, 1 in 164.

It is next to be noted that it is not the healthy but the sick who are preponderantly the occupants of the above institutions. The following tables show the percentage of total deaths from all causes which have occurred in these institutions; the general death-rate, and the phthisis death-rate of each country have been added for convenience of comparison. The Registrar-General of Scotland does not publish similar statistics as to institutions.

TABLE XXIX. ENGLAND AND WALES.

Percentage of Total Deaths in Public Institutions.

Years	Workhouses and Workhouse Infirmaries	Hospitals	Lunatic Asylums	Total Institutions	Death-rate per 1000 of Population: General	Death-rate per 1000 of Population: Phthisis
1869–70	5·7	1·9	0·7	8·3	22·42 (1866—70)	2·45 (1866—70)
1871–75	—	—	—	8·8	21·96	2·22
1876–80	6·3	2·4	0·9	9·6	20·79	2·04
1881–85	6·6	2·9	1·0	10·5	19·40	1·83
1886–90	6·7	3·4	1·1	11·2	18·89	1·64
1891–95	7·2	3·9	1·1	12·2	18·72	1·46
1896–1900	7·7	4·6	1·4	13·7	17·69	1·32
1901–03	8·5	5·9	1·8	16·2	16·18	1·23

TABLE XXX. LONDON.

Percentage of Total Deaths in Public Institutions.

Years	Workhouses and Workhouse Infirmaries	Public Lunatic and Imbecile Asylums	M. A. B. Hospitals	Other Hospitals	Total Institutions	Death-rate per 1000 of Population: General	Death-rate per 1000 of Population: Phthisis
1852–55	9·6	0·7	—	—	16·7	23·7	—
1856–60	9·0	0·6	—	—	16·3		—
1861–65	9·0	0·4	—	—	16·2	24·4	2·80
1866–70	9·1	0·5	—	—	16·3		2·86
1871–75	9·8	0·5	—	—	17·3	22·5	2·51
1876–80	11·3	0·4	—	—	18·6		2·40
1881–85	12·3	0·4	—	—	20·5	20·5	2·11
1886–90	11·8	1·9	0·7	8·7	23·1		1·88
1891–95	13·3	2·0	2·0	9·4	26·7	19·6	1·87
1896–1900	14·8	2·1	2·1	10·2	29·2		1·80
1901–04	17·7	2·8	2·2	12·2	34·9	16·9	1·65 (1901—04)

TABLE XXXI. IRELAND.

Percentage of Total Deaths in Public Institutions.

Years	Workhouses and Workhouse Infirmaries	Infirmaries and General and Special Hospitals	Public Lunatic Asylums	Total Institutions	Death-rate per 1000 of Population: General	Death-rate per 1000 of Population: Phthisis
1889–90	12·0	2·5	1·0	15·5	17·92	2·13 (1886—90)
1902–03	13·0	3·8	1·7	18·5	17·52	2·15

The figures of these tables show that a large and in recent years a continuously-increasing proportion of the population die in these institutions. The withdrawal of such proportions of the entire sick population into institutional segregation must, so far as they were infectious, have reduced greatly the amount of infection including tubercular infection left in the general population; and the comparison of the figures of such segregation with those of the phthisis death-rate shows that in England and Wales and in London this reduction has been out of all proportion larger than the convection, if any, arising from the aggregation of infectious cases in a general population of invalids under the ordinary conditions of English hospital or infirmary treatment. The figures are summarised in correlation-coefficients of ·91 for England and Wales (1878–1903) and ·90 for London (1866–1904), showing close co-variation of gross institutional treatment and of phthisis.

Institutional Treatment: Foreign Experience.

This experience is now to be compared with that of foreign countries, and it will be seen that the inquiry is carried into a larger number than was used in examining the other factors of phthisis. This course is desirable in regard to segregation and was unnecessary for the other factors, because each of the factors discussed earlier in this paper showed failure to maintain co-variation between the factor and the phthisis death-rate in one or more of the countries examined. This failure does not appear when segregation is tested over the same countries, and it is therefore necessary to extend the inquiry over a wider area in order to make sure that the continued concordance was not fortuitous.

The death-rate from phthisis in Norway (1904, p. 30) was—

1881 to 1890	1891 to 1900	1901 to 1902
141	189	192 per 100,000 of Population

In 1902, of the total deaths in Norway 5·9 per cent. occurred in the hospitals and lunatic asylums of Norway. The average duration of treatment of all the patients treated in hospitals in 1902 was 35 days. It is evident, therefore, that there is comparatively little institutional treatment of sickness in Norway as a whole, together with increasing phthisis. Separate hospital statistics could not be obtained for Christiania, but facilities for hospital treatment are doubtless more extensive than in the rest of Norway, and there has been considerable fall in its phthisis-rate.

Institutional Treatment: Sweden.

No Swedish statistics for the entire country are obtainable.

TABLE XXXII.

Death-rate per 100,000 *of Population from Phthisis.*

	1861–70	1871–80	1881–90	1891–1900
All Swedish towns together	306	324	300	270
Stockholm	433	406	346	292
Gottenburg	279	326	322	303
All other towns	195	299	277	256

Stockholm is the only town of Sweden showing any marked decline in its phthisis-rate. The detailed statistics show, both in small and large towns, either insignificant declines, or a stationary phthisis-rate. There are few hospitals in Sweden, as shown by the following extract from the report to the Paris Congress on Tuberculosis (1905, p. 205):—

"Notwithstanding the excellent general organisation of Swedish hospitals, only a small number of consumptives can be treated in them, owing to the fact that the great majority of the hospitals were organised only for the case of acute diseases. The official figures for 1890–1900 show that only about 1500 tuberculous patients have been treated each year in all the provincial hospitals of the Kingdom, while the number of patients suffering from tuberculosis is about 60,000 (1905, p. 4)."

Stockholm is better furnished with hospitals than the other towns, and it alone shows any decline of phthisis, though its death-rate is still very high[1].

Institutional Treatment: Denmark.

Statistics are only obtainable for Copenhagen. These have been kindly furnished by Dr E. M. Hoff, who has written to me in detail on the subject, and all the information embodied in the following table is calculated from his data:—

TABLE XXXIII. COPENHAGEN.

Phthisis and Hospital Treatment.

Years	Phthisis Death-rate per 100,000 of Population	Percentage of the Total Deaths from Phthisis which occurred in Hospitals	Cases of Phthisis treated in Hospitals per cent. of Total Deaths from Phthisis in the Population
1860–64	307	—	—
1865–69	297	—	—
1870–74	342	—	—
1875–79	314	—	—
1880–84	289	30	77
1885–89	251	27	88
1890–94	205	25	83
1895–99	183	28	80
1900–04	149	45	147

Evidently there is, as Dr Hoff states, a large amount of institutional treatment of phthisis in Copenhagen; and he adds that the average number of days' treatment for each patient has in recent years increased much more rapidly than the number of patients. More recently, further particulars have been published (1905, p. 7). It is stated that—

[1] R. Koch quotes Carlsson's statement that 410 cases of pulmonary phthisis are being cared for in the hospitals of Stockholm, "no small number for a city of 300,000 inhabitants" (*Lancet*, 26, v, 1906, p. 1450. Nobel Lecture on "How the Fight against Tuberculosis now stands").

"Notwithstanding the enormous increase of accommodation required, owing to the growth of the town and new ideas concerning phthisis, up to the present all requests for admission have been satisfied; and no consumptive desiring to be admitted has hitherto been refused owing to lack of room."

In 1895, on an average 40 beds in the municipal hospitals were always occupied by consumptives (deaths from phthisis in that year in Copenhagen, 661); in 1904, the number of beds thus always occupied was 270, not including the Sanatorium of Boserup (deaths from phthisis in Copenhagen in 1904 were 632). The mean duration of treatment of three successive series of cases of phthisis, in years from 1890–1904, was as follows:

TABLE XXXIV. COPENHAGEN.

	Mean duration of stay in Hospital in days	Mean duration of stay (days) in Hospital of Patients	
		Dying in the Hospital	Leaving the Hospital
Series I	40	42	40
,, II	107	112	105
,, III	107	98	110

It will be seen subsequently that the duration of treatment is about half the length of that in the Brighton Infirmary. The reduction of phthisis in Copenhagen, therefore, has been associated with a large amount of institutional treatment of the disease in general hospitals. The co-variation of the phthisis death-rate for Copenhagen during the period 1880–1904 and of the deaths from phthisis which occurred in the hospitals of Copenhagen is summarised in a correlation-coefficient of ·57. When segregation is measured for the same period by the proportion of cases of phthisis treated in hospitals to total deaths from this disease the coefficient of correlation with the phthisis death-rate is ·68. These figures express a fair co-variation between segregation as measured above and the phthisis death-rate.

Institutional Treatment: Prussia and Berlin.

Dr Hirschberg, the head of the Statistical Bureau of Berlin, has kindly furnished the figures from which Table XXXV has been calculated.

The curves of death-rates from tuberculosis in Prussia and of phthisis in Berlin have been given already in Fig. 3.

TABLE XXXV.

	PRUSSIA			BERLIN		
	Rate per 100,000 of Population of		For every 100 deaths from tuberculosis the no. of patients with tuberculosis treated in Hospital was	Rate per 100,000 of Population of		For every 100 deaths from tuberculosis the no. of patients with tuberculosis treated in Hospital was
Years	Deaths from tuberculosis	Cases of tuberculosis treated in General Hospitals		Deaths from tuberculosis	Cases of tuberculosis treated in General Hospitals	
1877–80	319	43	14	337	231	69
1881–85	311	53	17	332	255	77
1886–90	291	65	23	294	282	96
1891–95	248	77	31	244[1]	291[1]	119
1896–1900	212	91	43	213	313	147
1901–02	192	124	64	210	284	136

[1] Returns for 1891 missing.

It will be seen that, while in the whole of Prussia the number of cases of tuberculosis treated in general hospitals has increased from 14 for every 100 deaths from this disease in 1877–80 to 64 per 100 deaths in 1901–02, the death-rate from tuberculosis has declined from 3·19 to 1·92 per 1000. Similarly in Berlin the number of cases treated in Berlin has increased from 69 per 100 deaths from this disease in 1877–80 to 136 per 100 deaths in 1901–02.

There is reason for believing that the duration of treatment as well as the number of hospital patients has increased. It will be noted (Table XXXV) that the proportion of cases treated in hospital was greater throughout in Berlin than in Prussia. Collateral evidence shows that the duration of treatment of each patient has been shorter in Berlin than in Prussia. Approximately while Berlin had 153 beds (for all patients in its general hospitals) for every 100 in Prussia, it had 241 patients for every 100 in Prussia, for equal populations.

The above experience is summarised in correlation-coefficients between the annual returns of segregation and of phthisis or tuberculosis death-rates of ·95 for Berlin and ·93 for Prussia, showing close co-variation of the two phenomena.

It will be remembered that the general hospitals indicated above are not sanatoria. The limited operation of the latter has already been described on p. 352.

Institutional Treatment: Brussels.

In Brussels the death-rate from tuberculosis has declined from 3·21 per 1000 in 1886–90 to 1·97 in 1901–03. In the two great hospitals of Brussels (St Jean and St Pierre) the number of deaths from tuberculosis

to every 100 in the whole city was 12·2 in 1886–90, 15·6 in 1891–95, 17·3 in 1896–1900 and 38·9 in 1901–03. I am unable to obtain further information as to the character and duration of the hospital segregation of consumptive patients in Brussels, but the experience of Brussels appears to fit in with that of Copenhagen and of English towns. The correlation-coefficient between the annual segregation ratios from 1888 to 1903 and the corresponding phthisis death-rates in Brussels is ·76.

Institutional Treatment: Paris.

In 1902, 4828, *i.e.*, 41 per cent. of the total deaths from tuberculosis of the lungs and larynx in Paris occurred in its public hospitals. The average duration of stay in hospital of all patients admitted to its general hospitals was only 23·6 days in 1901. (Dr J. Bertillon.) The institutional treatment of phthisis in Paris is very short, and can have but little effect in preventing infection. We have already seen that in Paris there is probably no considerable decline of the death-rate from phthisis and that it remains much higher than that of any other city for which statistics have been obtained.

There is among the medical profession of Paris an impression that the Paris hospitals are a focus for tubercular infection. Thus, M. Mesurier states that the hospital attendants "suffer cruelly from contagion in the wards, two-thirds of them becoming tubercular (1905, p. 9)." He states also (1905, p. 16) that the hospitals contain 30 to 40 per cent. of consumptives. On the other hand Dr S. Bernheim, Vice-President of the Société Internationale de la Tuberculose (1905, p. 173), states:

"The Paris hospitals scarcely suffice for patients suffering from acute diseases, and can only, in view of their number, exceptionally admit consumptives. Furthermore, all the hospitals in our large centres of population, were they restricted to the treatment of tuberculosis, would not suffice for a tenth part of the consumptive poor of these towns."

The two statements here quoted can be partially reconciled by the fact that Paris hospitals are generally so overcrowded that consumptives make a very short stay in them.

Dr Bernheim, in a later paragraph, says:

"A consumptive never improves in our hospitals. We can allow the death in one of our beds of a consumptive with cavities; and, on the contrary, the curable consumptive has his fever increased in the presence of patients with serious lesions; and, in the inevitable over-

crowding, rapidly passes beyond the first stage of the disease, and on leaving the hospital has no further prospect of recovery. In this sombre statement I leave out of consideration the contamination of the hospital; and do not wish to speak of the unhappy typhoid patient who often leaves the hospital with consumption which he has acquired there."

On the whole, it may be said that it is doubtful, in balancing the possibilities of infection in Paris homes and hospitals, on which side the dangers are greatest. These hospitals, with a few exceptions, cannot under present conditions be regarded as institutions tending to reduce total infection. As a whole neither the extent of accommodation nor the average length of treatment is comparable with what is found in other countries. This, coupled with the uncertainty of the death-returns, would make it unsafe to include the French statistics, even if they were available in the consideration of the problem.

Institutional Treatment: United States.

In the cities of the United States a considerable and increasing proportion of cases of phthisis are institutionally treated. In Cincinnati, in 1885, 18·6 per cent., and in 1902–04, 34·6 per cent., of the total deaths from phthisis occurred in its public institutions. In San Francisco, in 1885–87, 30 per cent., and in 1902–04, 38 per cent., of the total deaths from phthisis occurred in its public institutions. In New York, in 1884, the death-rate from phthisis was 3·86, in 1903 it was 2·40 per 1000 of population. In 1882–84, 22·0 per cent., and in 1901–03, 26·0 per cent., of the total deaths *from all causes* occurred in public institutions. Dr Hermann Biggs writes me that he cannot give separately the number of deaths from phthisis in the public hospitals of New York; but he states that a census of tubercular patients in the public institutions in the boroughs of Manhattan and the Bronx has been taken twice a year for a series of years, and that the number of beds available for phthisis has greatly increased. At the present time there are 2,100 to 2,200 beds, chiefly for the care of advanced cases. Fifteen years ago the number specially devoted to this purpose was scarcely more than a quarter of this number, certainly not in excess of one-third. He adds that in little more than a year they will probably have over 3,000 beds for tubercular patients: though even this number is insufficient. The number of deaths from phthisis in Manhattan and the Bronx in 1903 was 5,250. This implies—assuming the above beds to be always occupied—that

every advanced case of phthisis in the city has had in recent years an opportunity of being segregated in a hospital during 21 weeks. Doubtless a smaller number, representing the poorest and therefore the most dangerous part of the phthisical population, were segregated for a correspondingly greater part of the year.

During the years 1881–1903 the coefficient of correlation between the phthisis death-rate and the proportion of deaths occurring in public institutions was ·75. This figure in itself shows a well-marked co-variation of the phenomena in question. Its significance is the more notable when it is considered in connection with the amount of over-crowding in New York (page 327).

TABLE XXXVI.

ENGLAND AND WALES.

	No. per 100,000 of Population of			Segregation Ratio. For every 100 indoor Paupers there were	
	Deaths from Phthisis	Indoor Paupers	Total Paupers	x deaths from Phthisis	x total Paupers
1866–70	245	726	4652	34	641
1871–75	222	662	3828	34	578
1876–80	204	668	2982	31	446
1881–85	183	730	2870	25	393
1886–90	164	709	2749	23	388
1891–95	146	687	2489	21	362
1896–1900	132	692	2356	19	340
1901–03	123	688	2218	18	322
		SCOTLAND.			
1866–70	259	253	3896	102	1540
1871–75	248	224	3210	111	1433
1876–80	230	235	2597	98	1105
1881–85	211	236	2742	89	1162
1886–90	188	224	2168	84	968
1891–95	176	212	1978	83	933
1896–1900	168	227	2085	74	919
1901–03	147[1]	242	1922	61	794
		IRELAND.			
1866–70	182	963	1233	19	128
1871–75	190	882	1389	22	158
1876–80	200	903	1569	22	174
1881–85	208	1019	2198	20	215
1886–90	213	954	2332	22	244
1891–95	214	906	2204	24	243
1896–1900	213	944	2244	23	237
1901–03	215[1]	947	2272	23	240

[1] 1901–02.

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Segregation measured by the ratio $\frac{\text{indoor pauperism}}{\text{total pauperism}}$.

The general course of pauperism in the countries of the United Kingdom has already been shown in Figs. 12 to 15. They may now be made to afford information as to segregation. The figures for phthisis compared with those of segregation measured alternatively by the proportion of indoor to total pauperism or of indoor paupers to total deaths from phthisis in the community are given in Table XXXVI for each quinquennium from 1866–70 onwards for each country of the United Kingdom.

The table of annual segregation ratios and annual phthisis-rates (not here reproduced) of which Table XXXVI is a summary, is further summarised in the correlation-coefficients given below, to which for convenience of inspection are added the correlation-coefficients between total pauperism and phthisis.

TABLE XXXVII. *Correlation-Coefficients*[1] *between Phthisis Death-rate and*

	Period	(*a*) $\frac{\text{Indoor Pauperism}}{\text{Total Pauperism}}$	(*b*) Total Pauperism
England and Wales	1866–1903	− ·94	+ ·89
Scotland	1868–1902	− ·91	+ ·90
Ireland	1866–1902	− ·85	+ ·83

The figures for the terminal quinquennia given in Table XXXVIII, exhibit the same experience more clearly, but in less detail. The figures for London are included.

TABLE XXXVIII. *Relative amounts of Institutional Segregation and Phthisis.*

	Proportional Phthisis death-rates, the death-rates for 1866—70 being stated as 100		Proportional amount of Institutional Pauperism, the fraction $\frac{\text{indoor pauperism}}{\text{total pauperism}}$ for 1866—70 being stated as 100	
	1866–70	1901–03	1866–70	1901–03
England and Wales	100	50	100	194
London	100	58	100	265
Scotland	100	57	100	186
Ireland	100	118	100	54

[1] These coefficients have been calculated not from the quinquennial rates given in Table XXXVI, but from the records for the long series of single years.

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Sample Individual Experience in Workhouses and Workhouse Infirmaries.

In default of figures directly expressing the phthisis experience of workhouses and workhouse infirmaries in recent years, special inquiries have been made as to sample districts of which the results will be briefly stated.

Workhouses have for as long as statistics of phthisis are available been the refuge of consumptive patients unable to work and earn their living. This has been so during the whole period, but to an increasing extent as the poor-law organisation has become extended and more humane. Pauperism has declined in England and Wales, so that whereas in 1848–9 over one-sixteenth of the population, in 1902–3 only one-fortieth of the population were paupers. This reduction is wholly due to a reduction in the number of able-bodied who receive out-door relief. Mr Fleming speaks of the "great change in the character of workhouse inmates during recent years... The able-bodied inmates are gone, and the sick inmates have come (1902–3, p. 84)." Thus, with a decreasing pauperism, we have a fairly stationary (in London an increasing) use of workhouses and infirmaries in proportion to population. And this fairly stationary use represents a great increase when stated in terms of *sick inmates*. When we remember that tuberculosis is one of the most common causes of sickness, this is equivalent to stating that workhouse-infirmaries are used to a much greater extent for this disease than in the earlier history of poor-law administration.

As the result of a recent circular letter of inquiry, which was answered by 28 Boards of Guardians in London, and by the Guardians of 130 of the chief provincial towns of the Metropolitan poor-law districts, I ascertained that in 12 out of the 28 metropolitan infirmaries consumptives were treated in the same wards as other patients, in six, partially in separate wards, and in nine, entirely in separate wards. From one Metropolitan Board of Guardians no statement was received. The Boards of Guardians in 49 provincial towns treated consumptives in the same wards as other patients, in 13, partially in separate wards, and in 23, entirely in separate wards. How the pauper consumptives were treated in the remaining 45 towns was not stated.

It appears, therefore, that separate treatment of advanced consumptives in infirmaries is common, but that in more instances they are treated in general wards. This latter circumstance is interesting, when taken in context with the general reduction of the phthisis-rate, as indicating

that the superiority of infirmary treatment of such cases over domestic treatment under the ordinary home conditions of the poor does not depend chiefly on segregation from general patients, though this is desirable. The possibilities of infection to general patients in a well-regulated institution are at a minimum. From this point of view, it has appeared to me that to argue as to the degree of infectiousness of phthisis from the supposed immunity from infection of the staffs in hospitals for consumption is to attempt a comparison of hospital and domestic experience under conditions which are incomparable. In hospitals rigid observation of cleanliness as to spitting, and still more as to cleansing of rooms, is the rule; in the latter among the poor it is exceptional. The intimacy of contact is much greater in domestic life, and its duration throughout each day is at least twice as great in domestic as in institutional life for the staff employed.

There is less evidence as to the duration of stay of consumptives in workhouse infirmaries. That this is probably protracted is evidenced by the average stay of patients suffering from all diseases which Dr Downes has kindly supplied to me. The average number of days' stay for each patient in various provincial infirmaries in the year 1897 was: Salford 97, Leeds 95, Croydon 86, Birmingham 74, West Derby 60, Kensington 48 days. Even therefore if it be assumed that the average stay of consumptives is no more than the average stay of all patients, there is evidently segregation for a considerable period of their illness of a large percentage of the total cases of this disease. I have been able to obtain exact records of the duration of treatment of consumptives in three workhouse infirmaries, viz., Kensington, Brighton and Sheffield. In the Kensington Infirmary this was 144 days in 1898 and 95 days in 1902 (compare the average of 48 days for patients from all diseases in in 1897). In the Brighton Infirmary each phthisical patient during 1897–1905 on an average was institutionally treated 221 days (or 175 days not including patients still in the institution); in the Sheffield Infirmary during 1904, the average duration was 311 days. These averages represent widely varying limits. In November, 1905, I ascertained the duration of stay in the institution of the 30 patients suffering from phthisis then in the Brighton Infirmary, with the following result (in days, except where otherwise indicated):—2, 9, 21, 22, 28, 32, 36, 36, 86, 88, 91, 144, 235, 333, 338, 367, 372, 373, 522, 680, 703, 758, 931, 981, 1,114, 1,468, 1,836, 1,942, 1,944 days, 13 years[1]. Ten of these patients had previously been in the Infirmary.

[1] In Infirmary, 641 days; rest of time in workhouse. Was phthisical on admission to the latter.

The present extent of use of poor law institutions is indicated by the fact that in 1899 Dr Downes states that 31·4 per cent. of the total deaths from phthisis, and 18·3 per cent. of the total deaths from other forms of tuberculosis in London occurred in its workhouses and workhouse-infirmaries and sick asylums. In 1904, 33·5 per cent. of the total deaths from phthisis occurred in these metropolitan institutions.

The following table gives examples of the extent to which use has been made of workhouse infirmaries at successive periods for the treatment of phthisis, and shows the corresponding variations of the phthisis-rates of the towns concerned.

TABLE XXXIX.

	Brighton		Sheffield		Salford		Newport, Mon.	
	Phthisis death-rate	Proportion per cent. of total deaths from Phthisis in Institutions	Phthisis death-rate	Proportion per cent. of total deaths from Phthisis in Institutions	Phthisis death-rate	Proportion per cent. of total deaths from Phthisis in Institutions	Phthisis death-rate	Proportion per cent. of total deaths from Phthisis in Institutions
1866–70	2·95	9·6	—	—	—	—	—	—
1871–75	2·47	11·7	—	—	—	—	—	—
1876–80			2·23	6·3	—	—	1·86	6·3
1881–85	1·93	14·3	1·90	7·9	—	—	1·96	13·0
1886–90			2·06	10·3	2·36	14·4[1]	1·52	12·9
1891–95	1·63	15·8	1·51	14·3	1·94	19·2	1·40	14·8
1896–1900			1·35	20·0	1·78	23·5	·97	13·5
1901–04	1·40	20·2	1·05[2]	26·1[2]	1·82	27·6	1·04	13·6

[1] 1884–90. [2] 1901–05.

The correlation-coefficient between the phthisis-rates for the long series of single years and the segregation ratios formed by a statement of the proportion per cent. of total deaths from phthisis in Institutions, during 1884–1904 was ·67 for Salford and during 1876–1905 was ·80 for Sheffield.

It will be seen that the conclusions to which the experience of these sample towns tend are the same as those deduced from the obervations of the phthisis-rates and segregation-ratios on a broader scale.

The degree of co-variation between phthisis and segregation which this table shows may be considered instructively in the light of a hypothetical calculation suggested by Sir Hugh Beevor (1905, p. 130). It is desired to ascertain what numerical effect can be expected from a given amount of segregation. In Brighton 20 per cent. of the total consumptives are segregated in its workhouse infirmary, and for the purpose of this calculation, this proportion may be supposed to hold

good for England and Wales. The examples already given suggest that one-third of a year may be taken as the average stay of each patient, and Sir Hugh Beevor in common with others would put the total period of infectivity at three years. If these figures hold good for England and Wales it follows that just over 2 per cent. of the total infection of phthisis is prevented from spreading outside institutions. On this supposition, and if personal infection were the sole means of communicating the disease, the death-rate from phthisis ought to have declined in each year to the extent of the segregation, namely 2 per cent. A reference to Table XXIV shows that from 1871 to the present time the decline year by year in the death-rate from phthisis has been usually under 2 per cent. The calculation, although interesting and suggestive, does not, of course, give any accurate measure of the institutional segregation of phthisis, or even of its practical effect. I give it, however, because it may not be realised generally how important small figures are in this matter, and how far-reaching may be the result of any sustained withdrawal of infection from the community.

Phthisis in Institutions other than Workhouse Infirmaries.

The course of phthisis in institutions other than workhouse infirmaries can be briefly summarised. The numbers given in Table XXIX and Figures 11 to 14 do not include lunatics in county and borough asylums and in other institutions. As will be seen by reference to Table XXIX the deaths in lunatic asylums and in general hospitals form a large percentage of the total deaths.

County and borough asylums, registered hospitals, and licensed houses for the reception of the insane and imbecile, contained in the year 1880, 15 per 10,000, and in 1902, 24 per 10,000 of the total population of England and Wales. The number of pauper lunatics per 10,000 of population was 30·54 in 1902, the total number of lunatics being 33·55 per 10,000. The following table illustrates the increase of institutional treatment of these patients:—

TABLE XL. ENGLAND AND WALES.

Distribution of Pauper Lunatics, Idiots, and Persons of Unsound Mind, per cent. of total number.

Year	In Asylums, Hospitals, and Licensed Houses	In Work-houses	With Relatives or others
1859	56·2	25·4	18·4
1902	77·4	17·1	5·5

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The death-rate from tuberculosis among lunatics in borough and county asylums in 1901 was 15·8 per 1,000 inmates, and this death-rate affects about one three-hundredth of the total population of England and Wales, whose average residence in the asylum is about five years.

It is well known that insane consumptives seldom expectorate. Doubtless this does much to limit the spread of infection, but the segregation of such an enormous number of these patients from the general population must have a material influence in reducing the death-rate from phthisis. The value of asylums as a means of segregating consumptives is indicated by Dr Mott's results, which go far to dissipate the view that the greater part of the enormous amount of phthisis among lunatics (Mott, 1904, p. 1) is due to intra-hospital infection. He states: "I have formed the opinion from the following facts observed post-mortem, that in a majority of cases (at least 58 per cent.) of tubercle, the disease is not acquired in the asylum," and gives the pathological data on which this opinion is based[1].

In his report for the year ending March, 1905, he confirms the above results from wider experience, stating: "the staffs of the asylums are singularly free from tuberculosis, and from the post-mortem examinations which I have made at Claybury and Colney Hatch I have formed the opinion that the great majority of the patients who die with active or obsolete tubercle undetected on admission were nevertheless then the subjects of the disease."

Dr Mott, in his evidence before the Royal Commission on the Feeble-minded, has urged the segregation of feeble-minded patients, because of their liability to become tuberculous and to spread infection to other children. It is clear from the above brief summary, that one three-hundredth of the total population having at least ten times as much phthisis as the average members of the community, are effectively segregated in asylums.

Special hospitals for consumption, notwithstanding Koch's dictum, can have had only a small effect on the past total amount of phthisis, owing to the disproportion between accommodation and need.

General hospitals have in the past treated a considerable number of consumptives; but an increasing unwillingness to admit such patients is shewn in the returns of most general hospitals. Thus in the Royal Infirmary (general hospital) of Glasgow 16·9 per cent. of the total deaths

[1] If the death-rate from phthisis among the inmates of lunatic asylums held good in the general population, two out of every three total deaths would be due to this disease.

were due to phthisis; in 1898–1902 the proportion had fallen to 4 per cent. With this diminution of treatment of phthisis in general hospitals has been associated the great increase in its treatment in workhouse infirmaries already indicated.

In summarising the results of this inquiry it is scarcely necessary to point out that many of them merely confirm previous knowledge. As however they present the phenomena associated with phthisis in a somewhat different perspective from that usually held to be correct, and as in particular the influence of institutional segregation, the study of which was the first purpose of this inquiry, can only be apprehended justly when taken in context with the other factors of phthisis prevalence, I have set them out together without distinguishing between what is old and what rests on the facts and arguments of this paper. The conclusions will be understood to relate to the period which has been under examination.

Conclusions.

(1) In each country and city of which the experience has been examined the general death-rate has decreased. In every case in which the phthisis-rate has also decreased, the decrease in the phthisis-rate has been greater and in most instances far greater than that in the death-rate from all other causes. The largest increase of phthisis death-rate in any of the countries examined occurred simultaneously with nearly the largest decrease of the death-rate from all other causes. The variation in the phthisis death-rate must therefore have involved variations in some phenomenon or group of phenomena which had no material influence on the death-rate from the aggregate of causes other than phthisis.

(2) For various reasons the separate investigation of the effect on the prevalence of phthisis which has been exerted by provision of increased light and air, suppression of dust, and drainage of subsoil is not essential to the present discussion.

(3) Increase of urbanisation, including increase of industrial occupation, has favoured the increase of phthisis, but its influence on urban phthisis has been counteracted wholly by the other factors of the phthisis rate. In urban as in national statistics the decline in the phthisis death-rate, where it has occurred, has exceeded the decline in the death-rate from all other causes to an extent and with a constancy which shows

the operation of some influence other than those to which the decline of the general death-rate is due.

(4) Improved housing and decreased overcrowding have been associated in most cases but not in all with reduced prevalence of phthisis; but great overcrowding has not usually sufficed to prevent great decrease of phthisis nor improved housing in all cases to prevent its rise. Overcrowding is an important factor of the phthisis-rate but its effect is usually not strong enough to counteract the influence of other factors.

(5) The course of the costs of wheat, total food, and total living varies closely with the course of phthisis in Great Britain, slightly in Germany and in the case of wheat in Paris, and inversely in Ireland. Compared with Great Britain, Germany and Ireland have lower wages and higher phthisis-rates, but Massachusetts has much higher wages and a much higher phthisis-rate. In both Great Britain and Massachusetts wages have risen and phthisis has fallen; but a considerable rise in wages has been accompanied in Ireland by some rise and in Norway by a large rise in phthisis. The consumption of food per head shows no correspondence with the extent of prevalence of phthisis; England with twice the meat consumption of Belgium has no appreciably lower phthisis-rate and no more rapid decrease in prevalence; France, judging by Paris, with high food consumption has by far the highest phthisis-rate, and with increasing food consumption shows no certain decrease in phthisis. It follows that the elements of nutrition have not exerted on the prevalence of phthisis an influence sufficient to counteract the other factors of its prevalence.

(6) A close co-variation is found between the figures of total pauperism on the one hand and the decreasing phthisis-rates of England and of Scotland and the increasing phthisis-rate of Ireland. Total pauperism may be taken as an approximate measure of total phthisis. Owing to the heterogeneous elements of which pauperism is composed, its variations cannot constitute an explanation of the variations in phthisis, though that explanation may lie in some element or group of elements of the phenomena which it includes.

(7) The decrease of phthisis where it has occurred cannot have been due to improved education as to the infectivity of the disease or to the introduction of Sanatoria, both of these having occurred after well-marked decrease had set in, and the Sanatoria up to the present time having been insignificant in number relatively to the amount of the disease.

(8) Institutional segregation of phthisis measured by the ratio of deaths or cases in institutions to deaths or cases in the total community shows moderate to close co-variation in the United Kingdom, London, Norway, Sweden, Copenhagen, Prussia and Berlin, Brussels, and New York. In Paris the character of the hospital treatment does not allow comparison to be made.

(9) Measured by the ratio of indoor to total pauperism which varies with administration or of indoor pauperism to total deaths from phthisis, the extents of segregation in England and Wales, Scotland, and Ireland show close co-variation with phthisis.

(10) Individual examination of the experience of many workhouses and workhouse infirmaries in various parts of the United Kingdom shows a constantly increasing use of these institutions for the treatment of phthisis, though a variable duration of treatment. Their total present use for the treatment of phthisis is very high, and in each of the four towns in which minute examination has been possible increasing use has been accompanied by decreasing phthisis. The extent to which infection is withdrawn from the community on the lowest figure of these instances would if applied over the country (pp. 370–371) determine approximately the amount of reduction in the phthisis death-rate which has in fact occurred.

(11) In England and Wales a large and increasing amount of phthisis is segregated in lunatic asylums and other institutions beyond workhouses and workhouse infirmaries.

(12) Segregation in general institutions is the only factor which has varied constantly with the phthisis death-rate in the countries that have been examined. It must therefore be regarded as having exerted a more powerful influence on the prevention of phthisis than any of the other factors of which none has varied constantly with the phthisis death-rate.

The Case of Ireland.

The Irish experience has been used in the preceding pages as illustrating the co-variation of pauper segregation with the phthisis death-rate under circumstances of *increasing death-rate as contrasted with the decreasing death-rate of England and* Scotland. It will be seen however that the absolute amount of segregation in Ireland (measured by the number of indoor paupers per 1000 of population), although much less than in London, has been greater than in England and far greater than in Scotland, and the phthisis death-rate has also been higher than in England from 1881–85 onwards and higher than in Scotland from 1886–90 onwards.

Moreover the rates of change in the proportion of segregation and in the phthisis death-rate, although always consistent with the general results already stated, have shewn much less numerical concordance in Ireland than in Great Britain. As an illustration of the method adopted in this inquiry it may be instructive to examine these quantitative discrepancies somewhat more minutely.

The differences in the rates of change may be seen most easily by plotting logarithmic curves on which equal vertical distances will be proportional to equal rates of change of the quantities plotted. This has been done for the pauper segregation-ratio (inverted) and the phthisis death-rate in Figs. 16 to 18 for each country; and in Figs. 19 and 20 the inverted segregation-ratio of institutional to total deaths is substituted for the pauper segregation-ratio.

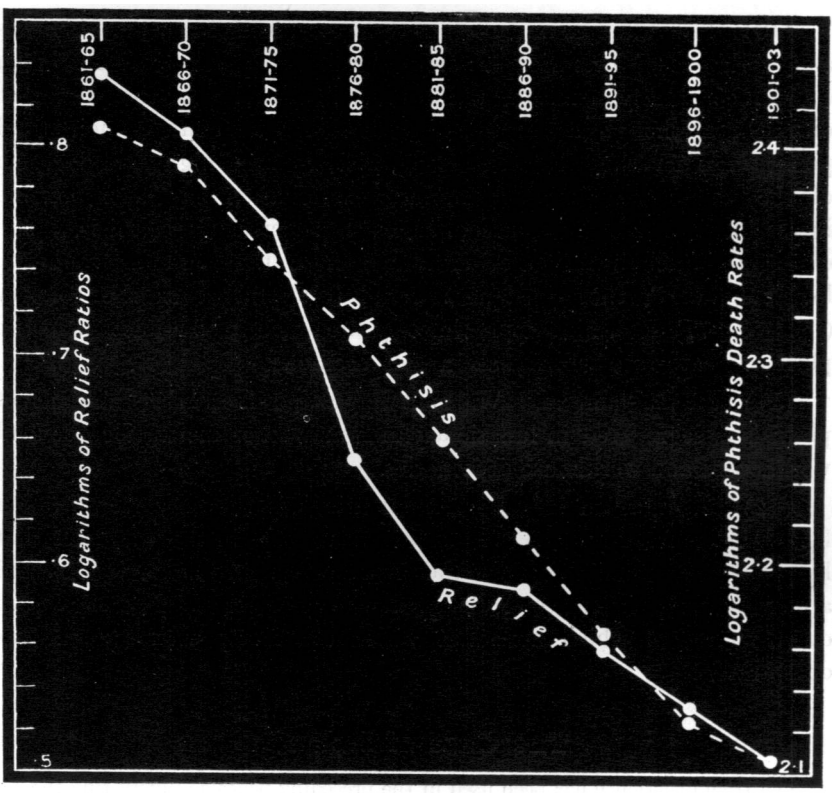

Fig. 16. England and Wales.—Logarithmic Curves of Phthisis Death-rates and of Ratio of Total to Indoor Relief of Paupers—1861–65 to 1901–03.

Inspection of these curves shows that the rate of change of the phthisis-rate in Ireland, while following the rule as to increase or decrease with the segregation-ratio, was much slower in relation to it than either in England or Scotland, though in all three countries the change in these quantities was similar. The discordance between

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these rates of change might be due to one or more of three causes. The concordance in England and Scotland might be mere coincidence. This explanation has already been tested by pursuing the comparison of segregation and phthisis into a considerable number of countries, and ascertaining that the concordance between them seen in each country of the United Kingdom appears in each of the other countries. Had it happened, as has been seen to be the case with other important factors of phthisis, that in some countries antagonising influences disturbed the concordance, the causal connection between segregation and phthisis would not have been disproved, but the evidence in its favour would have been weakened, pending an explanation of the discrepancy or until concordance had been found in a sufficiently large number of other countries to make it probable that some unknown reason for the discrepancy existed. In actual fact this further examination has been unnecessary.

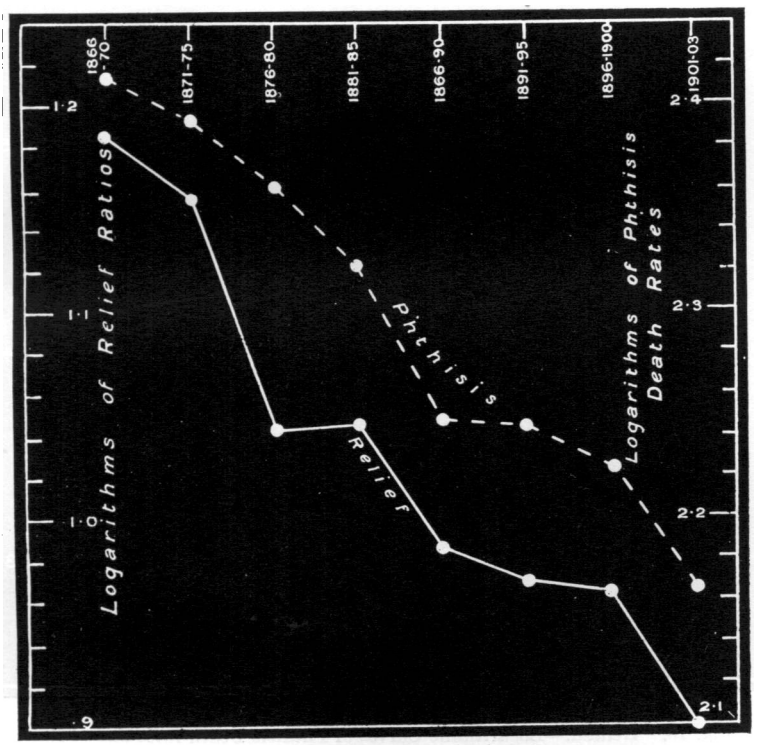

Fig. 17. Scotland.—Logarithmic Curves of Phthisis Death-rates and of Ratio of Total to Indoor Relief of Paupers—1861–65 to 1901-03.

Presuming, then, that general institutional segregation tends to reduce phthisis, it might be that in Ireland either the influence of factors which tended to increase phthisis has been greater or the nature and efficiency against phthisis of segregation

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less than in either of the other countries. It has already been seen that some, though not all, of the influences which favour phthisis have been stronger in Ireland, though hardly to such an extent as to explain the considerable discrepancy in the effect of segregation. It becomes therefore a matter of great interest to ascertain whether any existing circumstances in Ireland tend to lessen the specific value of segregation against phthisis; and it will be found that several factors affect the value of the ratio indoor to total pauperism as a measure of segregation in Ireland.

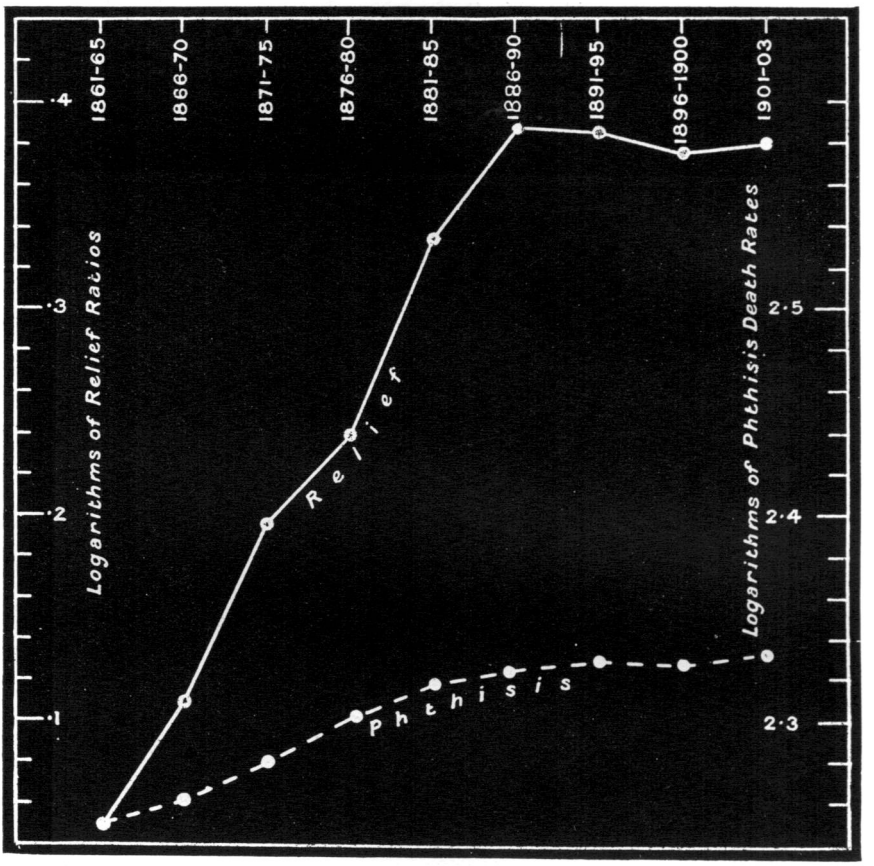

Fig. 18. Ireland.—Logarithmic Curves of Phthisis Death-rates and of Ratio of Total to Indoor Relief of Paupers—1861–65 to 1901–03.

The course of emigration has produced a notably different age-distribution of population in Ireland. Persons aged 60 years and upwards comprise 14·2 per cent. of the total population of Ireland, as compared with 10·4 per cent. of that of England and 10·9 per cent. of that of Scotland. Closely related with this is the fact that between 1881 and 1901 although the crude total birth-rate has fallen from 24·5

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to 23·1, this birth-rate corrected for number of women at child-bearing ages and for number of married women (Newsholme and Stevenson, 1905) has increased from 35·2 to 36·1 per 1000. These figures may be contrasted with the corresponding changes in England, in which the crude total birth-rate has declined from 33·9 in 1881 to 28·4 in 1901, the corrected total birth-rate from 34·7 to 28·4 per 1000. The non-decline of the corrected birth-rate bears on and does not appear to support the assumption that the long stream of emigration from Ireland has left behind a physically inferior population excessively susceptible to tuberculosis.

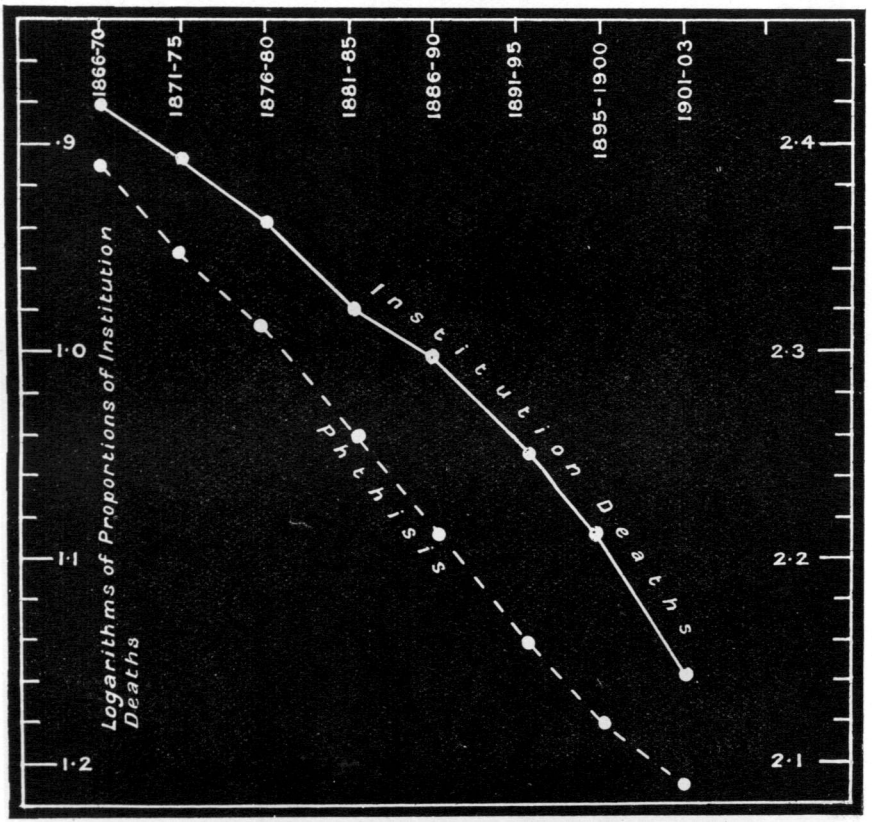

Fig. 19. England and Wales.—Logarithmic Curves of Phthisis Death-rates and of Proportion of Institutional to Total Deaths from all Causes.

It follows from the above facts that the population of Ireland contains a smaller proportion of persons at ages specially susceptible to phthisis, and a higher proportion of persons at ages when pauperism occurs, than either England or Scotland. On calculating the exact correction required to make the phthisis death-rate of Ireland in 1891 comparable with that of 1901, I find that the former becomes

17·7 instead of 19·3 per 10,000. In other words there has been a greater increase in the recorded phthisis death-rate than the crude figures display[1].

Apart therefore from any question of efficiency of the segregation given in

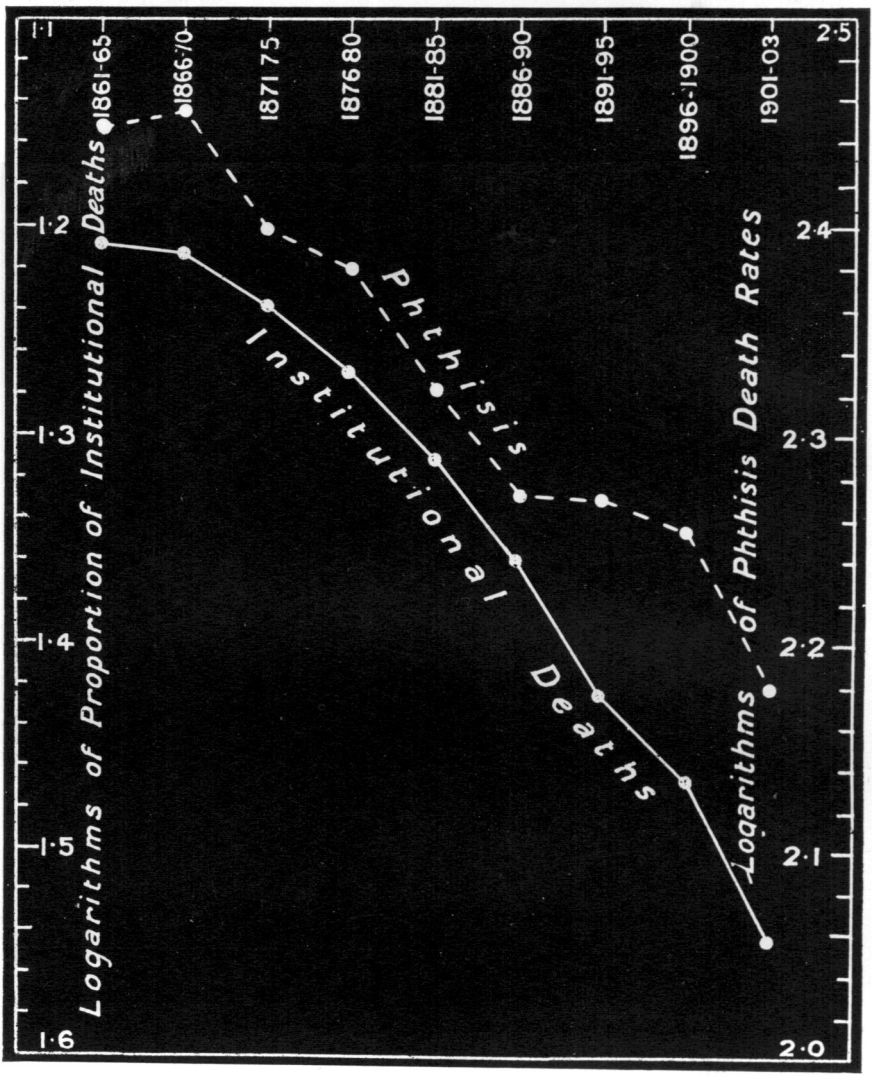

Fig. 20. London.—Logarithmic Curves of Phthisis Death-rates and of Proportion of Institutional to Total Deaths from all Causes.

[1] In England and Wales and in Paris similar corrections have been calculated: but the differences thus produced are immaterial (see *Epid. Trans.* 1906, p. 56).

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Ireland compared with that in England and Scotland, this segregation evidently exerts less effect on phthisis in proportion as the population is by reason of age-constitution less susceptible to the disease, and in proportion as the ratio of indoor to total pauperism is composed in a larger measure of non-phthisis cases. The inclusion among indoor paupers of a certain excess of non-phthisis cases arises in another way, which does not occur to the same extent in England and Scotland. The Census Report for 1901 (p. 33) states:

"The sick in the workhouse hospitals connected with the 159 poor-law unions of Ireland numbered 15,633, or three-quarters of the entire number of the sick in public institutions, while the number of inmates of the institutions commonly regarded as hospitals was 5,071. A large proportion of the 15,633 'sick in workhouses' should not be classed as 'sick paupers': the fact being that in country districts and small towns where there are no special and general hospitals, the sick among the artizan and labouring classes make use of the union hospitals, in the same manner as similar classes in the great towns use the hospitals supported by contributions and charitable institutions."

Local inquiry however shows that the assumption of efficiency in segregation is not well-founded. Speaking generally of workhouse accommodation the Annual Report of the Irish Local Government Board (1903–4, p. 9) states:

"During the year, the necessity for properly separating the sick who require hospital treatment from the destitute aged and infirm, who only require domestic care, has been pressed on the attention of many Boards of Guardians. While the importance of this classification has been generally recognised, and in some places practically enforced by the Guardians, most of the Boards consider that, in view of structural and other difficulties, a sufficient or satisfactory classification must await the action that may be taken on the Report of the Poor Law Reform Commission now sitting."

Such classification of inmates, including separation of workhouse from infirmary inmates, is the rule in England, the exception in Ireland. The extent of institutional segregation is greater in Dublin than in the rest of Ireland, the indoor paupers in the Unions of North and South Dublin numbering 94 per 1000 in 1903 as compared with 80 per 1000 in the rest of Ireland. The reports of the Irish Local Government Board give data which have enabled me to calculate the average stay of each pauper in workhouses. In North and South Dublin it is 70 days, in the rest of Ireland 39 days. Clearly therefore the institutional segregation of phthisis may be taken to be more extensive in Dublin than in the rest of Ireland. Yet Sir Chas. Cameron (*Ann. Rep.* 1904, p. 31) says concerning Dublin:

"The hospitals rarely keep consumptives whose cases are hopeless, to the termination of their disease by death. If such cases were retained in hospital, it would prevent the circulation of much tuberculous infective matter."

This statement is confirmed by the data contained in a return, kindly supplied by Mr J. E. Devlin of the Irish Local Government Board, which has enabled me to calculate the average duration of residence of phthisical patients in the Dublin workhouses. It is shown in the following table, in comparison with similar returns for English workhouses.

Average Residence (in Days) of all Phthisical Patients in Workhouses, to time of Discharge or Death (not including Patients still in the Institution).

Institution	Days	Based on experience of the undermentioned number of patients who have	
		Left the Institution	Died in the Institution
North and South Dublin Workhouses, 1904–05	53	272	156
Brighton Infirmary, 1897–1905	175	165	181
Kensington Infirmary, 1888	144	107	68
,, ,, 1902	95	151	112
Sheffield (Firvale) Infirmary, 1904 ...	311	—	—

The above return relates to North and South Dublin, which in 1903 had a population of 379,666.

It will be noted that, unlike the experience of Kensington Infirmary (see p. 369), the institutional residence of consumptive patients in the Dublin workhouses is less than that of all patients in the aggregate.

It seems probable, therefore, that, taking Ireland as a whole, the average residence in workhouses is not half so protracted as in England. To this fact must be added the very imperfect condition of Irish workhouses, making the balance of good on the side of institutional treatment much less than in England. It has already been seen that owing to the constitution and habits of the people a larger proportion of the institutional population than in England and Scotland consists of non-phthisis cases. It follows that segregation (as measured by number of indoor paupers to total population) has much less specific efficiency in Ireland than in Great Britain. The segregation history of Ireland at different periods may be compared with itself, but not in any quantitative sense with that of other countries. When thus compared, its experience teaches the same lesson as that of England and Scotland.

It will have been noted that in this inquiry comparisons have been freely made between the condition of different countries at a given period as regards food, housing, etc. ; but that the necessity of caution in making a similar comparison as regards segregation has been emphasised. The reason for this is obvious. Such factors as a given amount of food, of house accommodation, wages, etc. mean much the same in any country, and can with approximate accuracy be compared with the corresponding phthisis death-rates. It is otherwise with segregation until we can obtain more accurate measures of its duration and its character as well as of the number of persons temporarily segregated. Administrative variations like those shown in the experience of Ireland are enormous ; and country can only be compared with country so far as the general trend of observations goes. Each country needs separate study as to the contents of any institutional segregation which its statistics show.

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