how a very close approximation to these numbers may be obtained.

Briefly, the method employed is that known as osculatory interpolation, the terms on each side of the interpolated value being involved in proportions varying with their proximity to such value. The interpolation could have been effected by means of a freehand curve, but this would have been open to the objection that no two operators would have arrived at identical results. Where the table is constructed by a mathematical formula, a definite rule can be adopted, and every operator, whatever his degree of skill, must, if he follows the rules set out, derive the same results. Where the tables are required for comparison, this is an essential condition. The method is not applicable to infantile ages, and for these the system adopted has been based on the births and deaths of recent years.

CHAPTER VI

PRACTICAL USES OF MORTALITY TABLES BY MEDICAL OFFICERS AND OTHERS—CAUSES OF DEATH AND THEIR PREVENTION

I NOW want to illustrate by means of the mortality tables for England and Wales, London and Liverpool, the lesson which may be learnt from this branch of Vital Statistics.

In Diagrams 16 and 17 on pp. 78 and 82, are shown the rates of mortality according to :—

(1) The sixth English life table based on the two censuses 1891 and 1901, and the deaths for the intervening ten years.

(2) The table constructed for the purpose of the National Insurance Act based on the estimated population at June 30th, 1909, and the deaths for the years 1908–9–10.

(3) The life table for London based on the two censuses 1901 and 1911, and the deaths for the intervening period.

(4) A Liverpool life table based on the population and deaths in Liverpool for the year 1911. (See Appendix, Schedules G and H.)

(5) A life table on the basis of the population and deaths in 1911 in England and Wales. (See Appendix, Schedules E and F.)

The last-mentioned table and the Liverpool table I constructed for the purposes of the Chadwick lectures by the method to which I have already referred.

Considering first those tables based on the population of England and Wales, the point which must at once

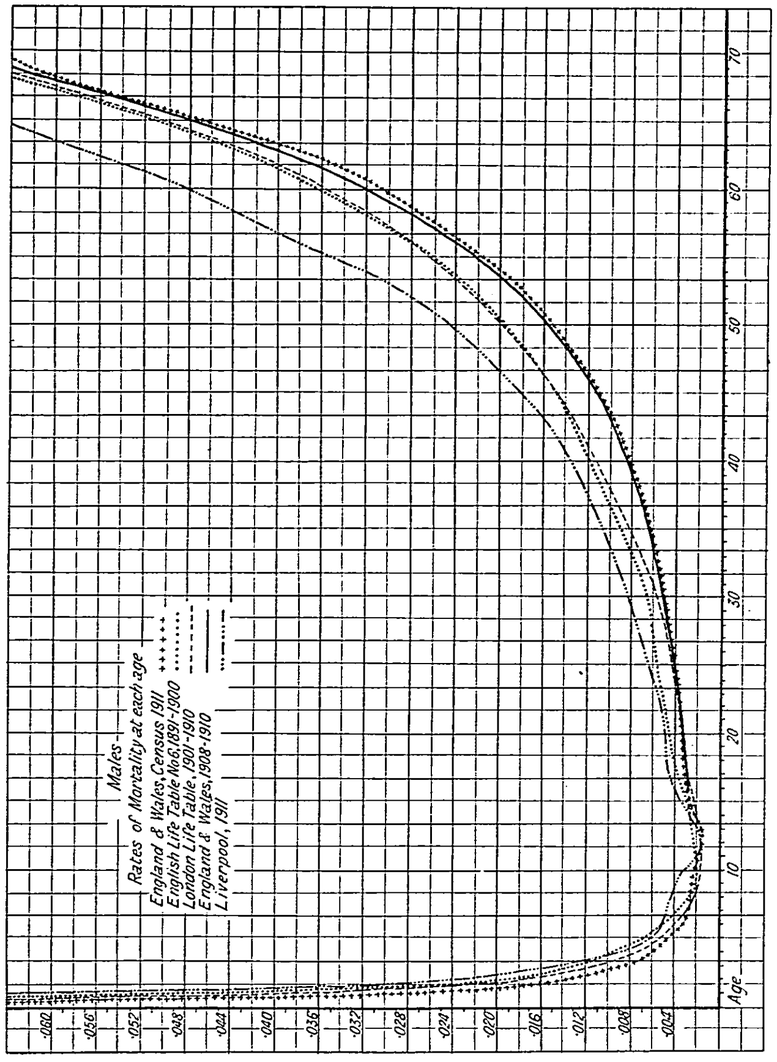

Diagram 16.

strike observers is the marked improvement in the rate of mortality experienced during the past ten or fifteen years. The National Health Insurance table, which commences

at age 15, is consistently below the sixth English life table, and it will be noticed that the lower mortality rates are most marked at the effective working ages, viz., from 30 to 50. These tables show the improvement that has taken place over an average period of thirteen years. The table for 1911 confirms the National Health Insurance table, and shows even lower mortality rates.

The Registrar-General's reports are not published until two years after the period to which the figures refer. The year 1911 is, therefore, the latest to which reference can be made. The steady improvement in the vitality of the country is so important that I thought it would be interesting to endeavour to discover if it was continued up to 1913. I have, therefore, examined most carefully the rates of mortality in the industrial branch of my own office over the range of ages shown in the diagram. The rates are based upon 20,000,000 policies, the holders of which are living in every part of the United Kingdom, so that they fairly represent the population. In fact, so representative is our business, that we can say that we have our finger on the pulse of the nation, and we always find that a change in our experience is confirmed by the Registrar-General's figures when they are published subsequently.

My examination of the Prudential rates of mortality for 1913 shows that the improvement is maintained, the death rates being consistently less at every age. This means an enormous increase in the numbers of working years of life saved to the nation. A more eloquent tribute to the labours of those concerned in public health can hardly be found.

The fact that all four experiences show a continuous reduction in mortality rates indicates that the improvement is not due to exceptional causes, and is striking evidence

that the efforts of sanitary reformers generally are producing a rich harvest in the improved health, and, I think I may add, the happiness, of the people of these islands.

Dealing now with the two local tables, viz., London and Liverpool, it will be seen that the rates for both districts exceed those of the general population, the London rates, however, being the lower of the two.

I think that it should be the ideal of each district to reduce its mortality rates, so that they will compare favourably with the rest of the country. It is unfortunately the fact that the wastage of life in urban districts is greater than in rural districts, and the reason given is that in the latter the conditions of life are so much better. Pure air, the freedom from dust and dirt, and all that this implies, give the rural dweller a better chance of life than the townsman. While agreeing that the rural dweller has these advantages, I am convinced that many of the disadvantages from which the townsman now suffers are preventable and will be prevented in the future to such an extent that the rates of mortality for urban districts will be equally as favourable as those of rural districts.

The life of the citizen is as valuable to the community as that of the rural worker, and he has the right to demand that, as his property is protected from the crimes of evil doers, so his health and the health of his family shall be protected from the curse of preventable diseases, caused in too many cases by persons whose thoughtlessness amounts to criminality.

The standardised death rate shows that Liverpool's mortality is higher than the average for England and Wales. The diagram enables us to see where the excess occurs. Dealing first with the males, the deaths amongst infants under 1 year of age were not very dissimilar, being 141 per 1,000 for England and Wales, and 163 per 1,000

for Liverpool. Between ages 1 and 2 the death rates were 40 per 1,000 and 73 per 1,000 for England and Wales and Liverpool respectively, and from 2—5 they were 9 per 1,000 and 15 per 1,000. That is to say, whereas for the first year of age, the excess was only 16 per cent., from age 1 to age 5, the excess was over 70 per cent. From age 5 to age 25 the excess was approximately 42 per cent. From 25—45, the principal working years, it was 64 per cent., and from 45—65 the rates were 21 per 1,000 for England and Wales, and 34 per 1,000 for Liverpool, an excess of 61 per cent.

With regard to the females the diagram on p. 82 shows that the rates were lower throughout life than those for the males with the exception of the age-group 5—15, where the rates are practically the same for both males and females. The female rates, although higher than those of the general female population, compare more favourably than is the case with the males ; the incidence of the excess is, on the whole, distributed over the various age-groups in much the same proportion as in the case of males.

I now come to the analysis of the causes of death, and it is to this analysis that I attach the utmost importance. The standardised death rate showed the excess. The mortality tables to which I have just referred showed what proportion of this excess was attributable to each age. It is the function of the analysed tables to show to what causes the excess at each age is due. The publication of the data in the Registrar-General's 1911 report enables this to be ascertained for the first time. The deaths from various causes are given in this report for the age-groups 0—1, 1—2, 2—5, 5—15, 15—25, 25—45, 45—65, and 65 and over. In future reports they will, I hope, be given for smaller age-groups, because this will permit of a closer

analysis being made than is possible at the present time, For the purpose of my analysed tables I have grouped

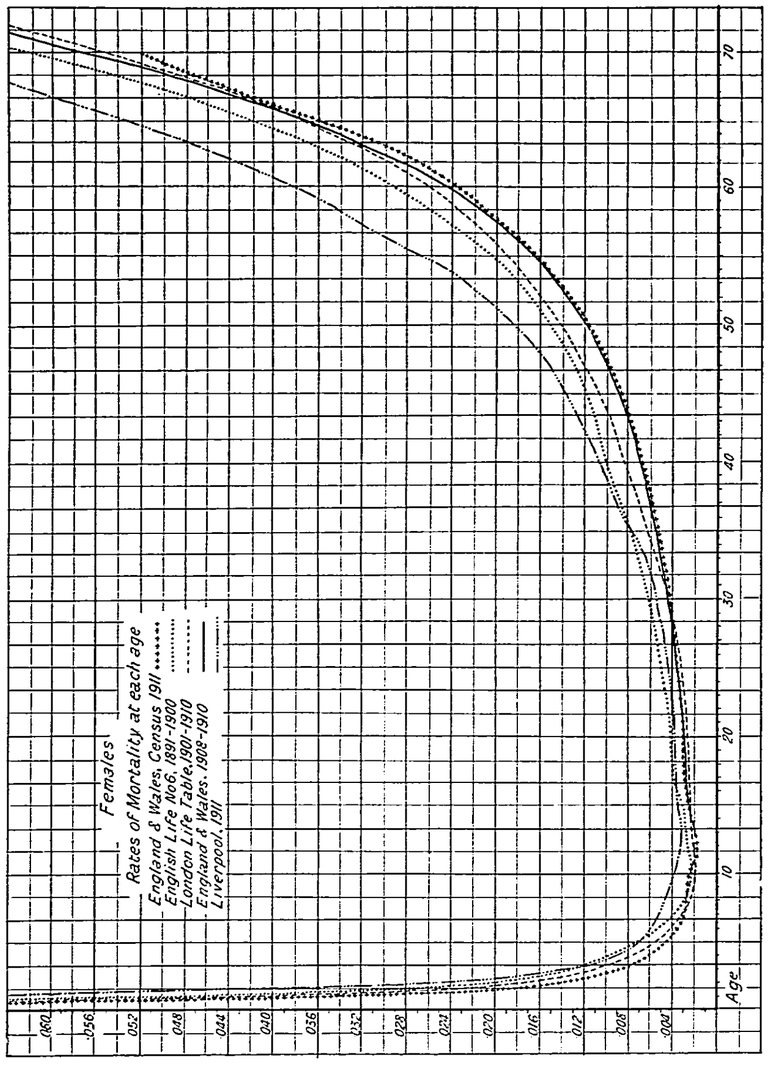

Diagram 17.

the various diseases into five classes, and for each age-group I have split up the death rate into its component parts. I am thus able to show for each age-group the

proportion of the rate that is attributable to each of these five causes. The grouping I have adopted is as follows:—

A. Tuberculosis, including pulmonary tuberculosis, tuberculous meningitis, and other tuberculous diseases.

B. Cancer.

C. Other diseases of known microbic origin. These include enteric, small-pox, influenza, rheumatic fever, puerperal fever, erysipelas, bronchitis, pneumonia, and other respiratory diseases.

D. Infantile complaints, including measles, scarlet fever, whooping cough, diphtheria, diarrhœa, congenital debility. This group has been confined to ages under 15.

E. All other causes of death.

In the diagram on p. 84 is shown the mortality rates for England and Wales for males in 1911, sub-divided according to these five causes. The area between the base line and the first line shows the proportion due to tuberculosis; the area between the first line and the second line, the proportion due to cancer; and so on, as indicated in the diagram. The fifth or top line, which encompasses the whole area, represents the total death rate. It is instructive to notice that if we exclude the deaths from infantile complaints included in group D, the curve is very much reduced. For instance, at age 2 it is about halved, whilst at age 1 it is reduced to about one-third. I would particularly call your attention to the high rates of mortality due to tuberculosis at the early ages; the rate steadily decreases until age 7, thereafter it steadily increases until about age 50, and then decreases for the remainder of life.

In the diagram on p. 85 are shown the analysed rates of mortality for Liverpool males in 1911.

There are several features in this diagram to which I would direct attention. With regard to tuberculosis, it

will be seen that it presents the same characteristics as that for England and Wales, but in an exaggerated form.

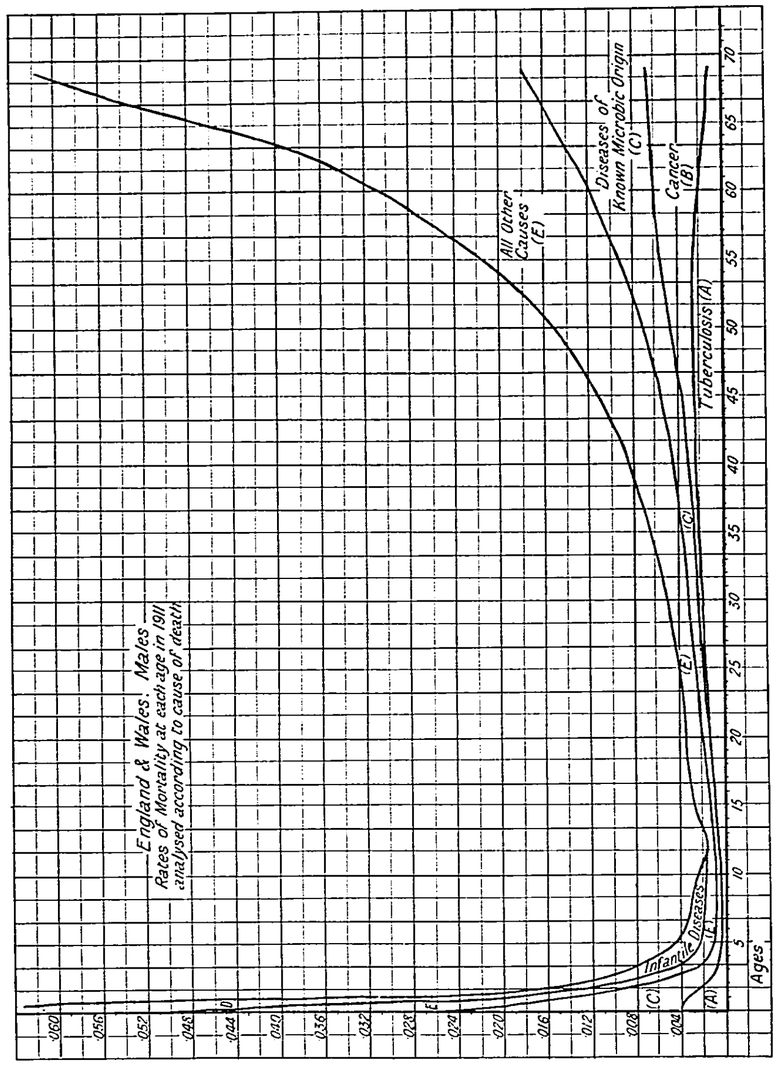

Diagram 18.

A large proportion of the total death rate is due to the diseases of known microbic origin, which include bronchitis and pneumonia and other respiratory diseases, and

the point I wish to emphasise is that they are, at least to a very great extent, preventable. In fact, all the causes

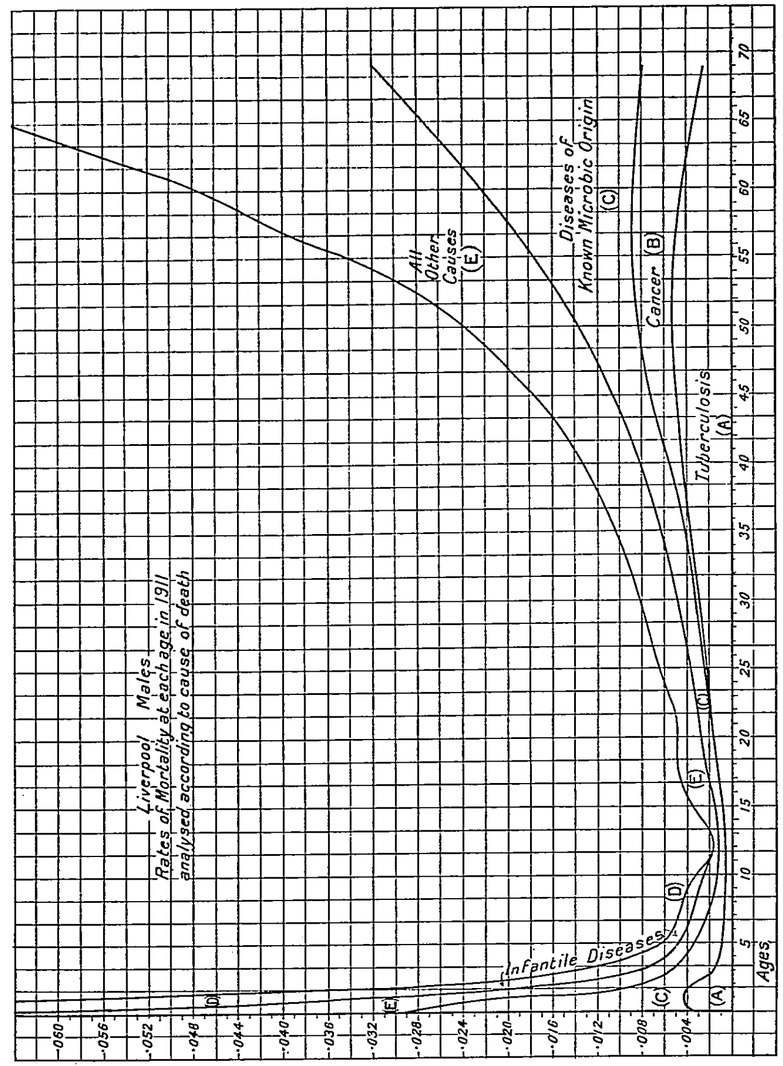

Diagram 19.

A, B, C, and D, are in the nature of preventable diseases. If we ever succeed, and I trust we may, in entirely eradicating the diseases included in groups A, B, C, and D,

there can be no doubt that we shall have added many years to the working life of the community, but it is, of course,

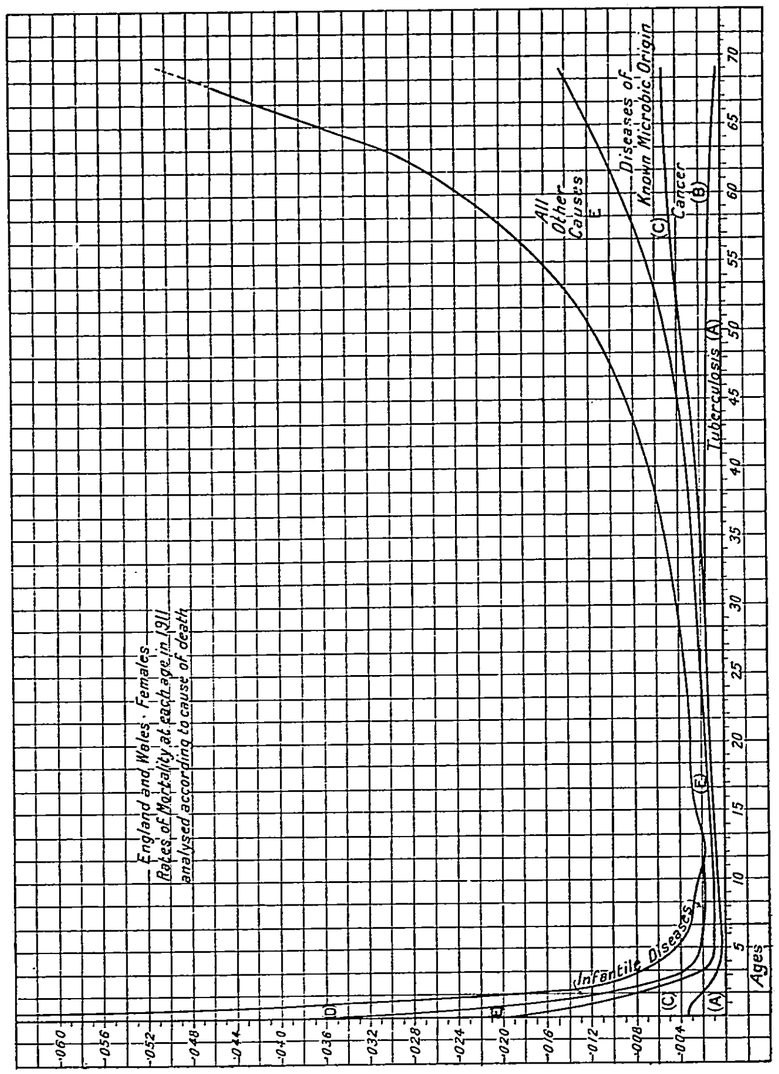

Diagram 20.

impossible to predict what the rate of mortality would then be. We may reasonably suppose that a healthier nation would be capable of greater resistance to other

diseases, but on the other hand new diseases may be developed.

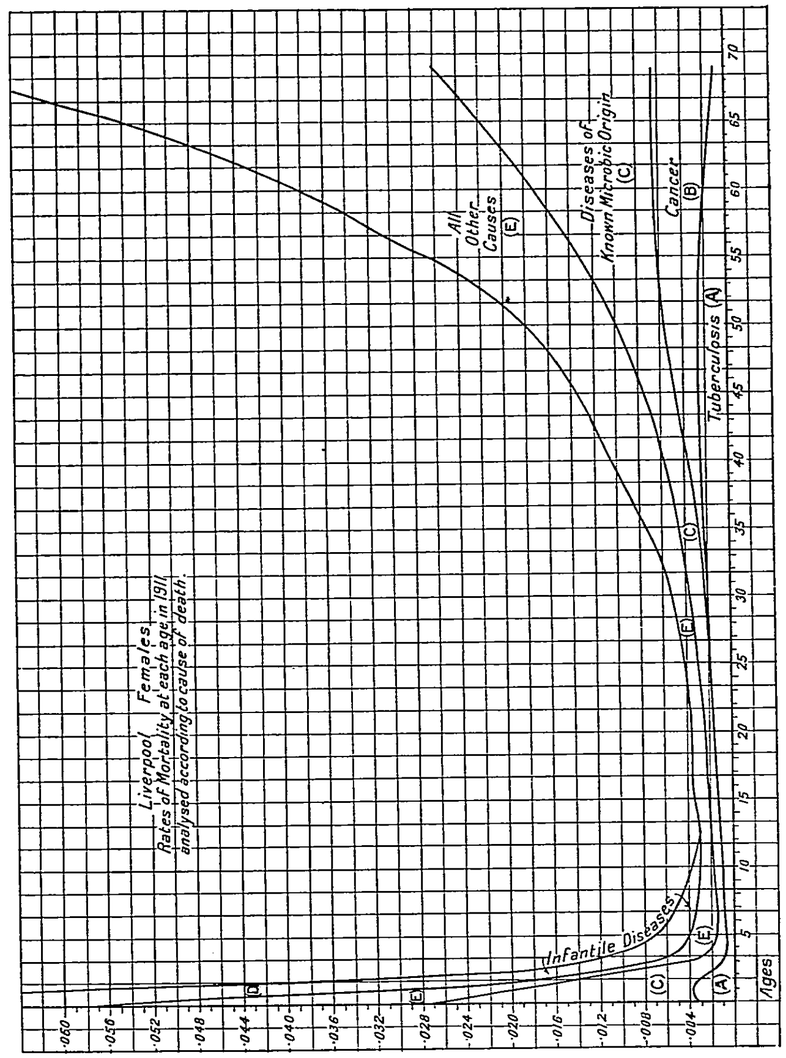

Diagram 21.

Quite apart, however, from any uncertainty as to the eventual future rates of mortality, the great fact presented is that hundreds of thousands of deaths occur yearly in

this country which could be prevented. If I could but succeed in impressing this great fact upon the nation at large, I believe that sanitary reform and the improvement

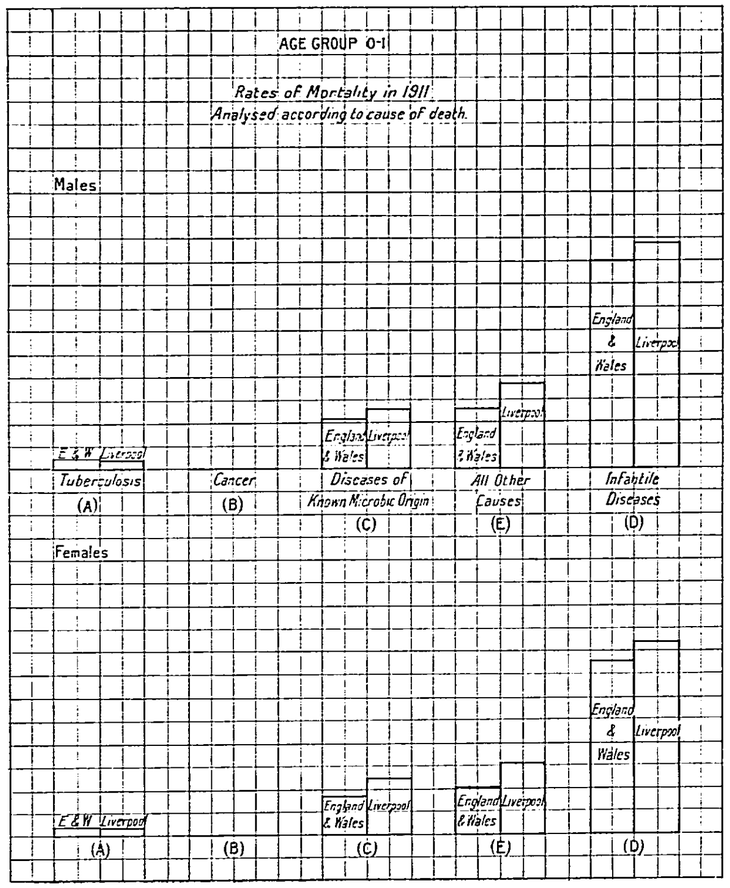

Diagram 22.

of the public health would be recognised as a matter of far greater national importance than the majority of political and other questions which attract such constant public attention.

The analysis of the death rates in a manner such as I

have explained enables each district to see the extent of the waste in its own case and the ages at which this waste occurs, thus enabling anyone to bring the matter quite clearly before the public notice.

I have referred to the Liverpool rates of mortality for

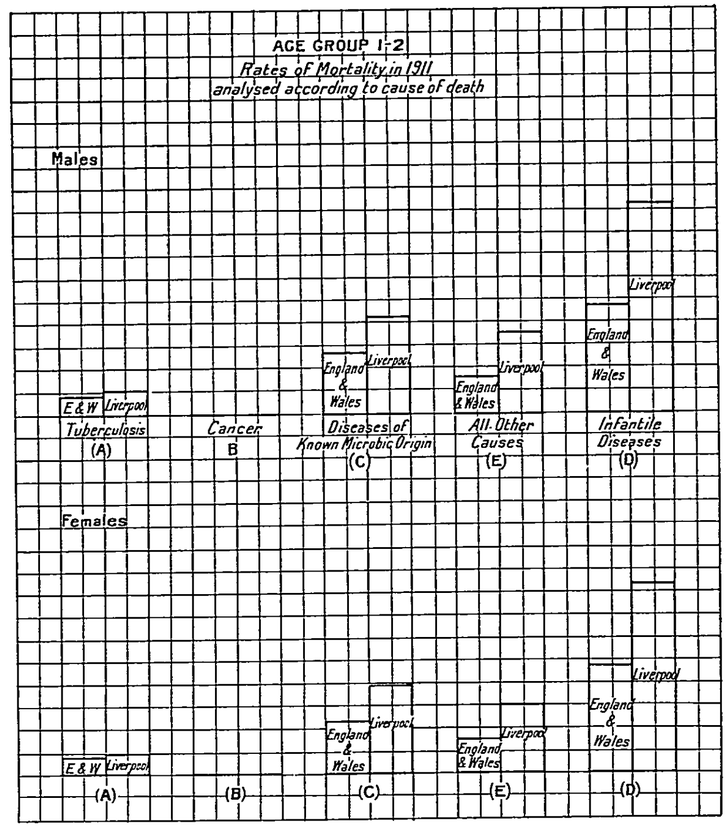

Diagram 23.

the sole reason that I delivered my lectures in Liverpool, and my desire is to show how the amount of preventable disease in any district can be detected. I am well aware of the enormous strides which have been made in sanitary reform in Liverpool, and the peculiar difficulties to

which this great city is subject. In using the tables of analysed mortality each year, the progress which is being made will be shown beyond contradiction, and to my mind, once it is exhibited in this graphic form, the effect on

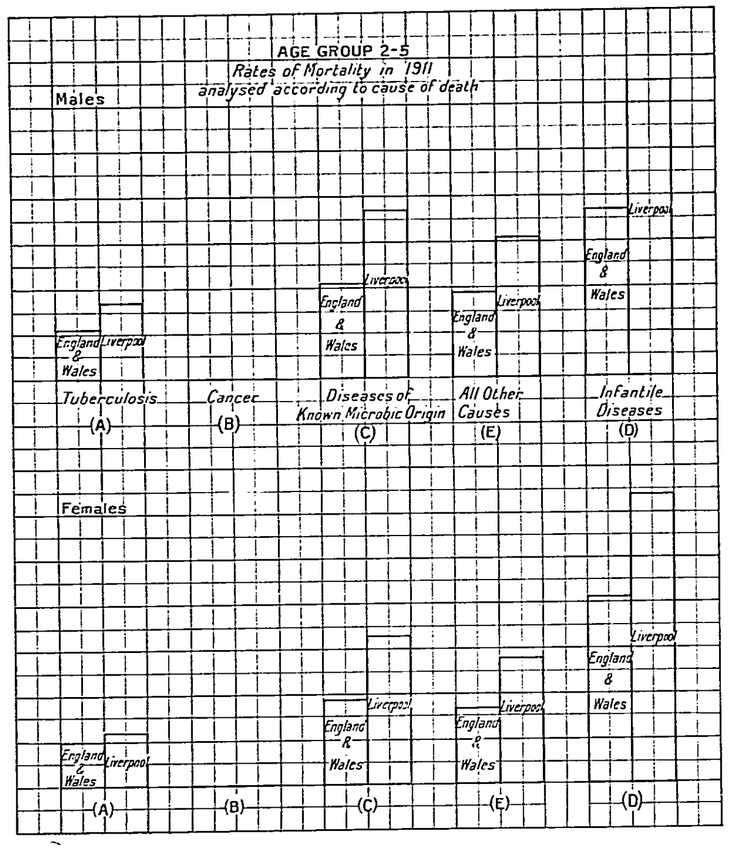

Diagram 24.

public opinion will be such that the remedy must inevitably follow. I say public opinion deliberately, for, without this backing, the efforts of the medical officer are more or less unavailing.

In the diagrams on pp. 86, 87 are shown the analysed

rates of mortality for females for England and Wales and for Liverpool.

Now I should like to show the analysed results for England and Wales and Liverpool in a somewhat different form.

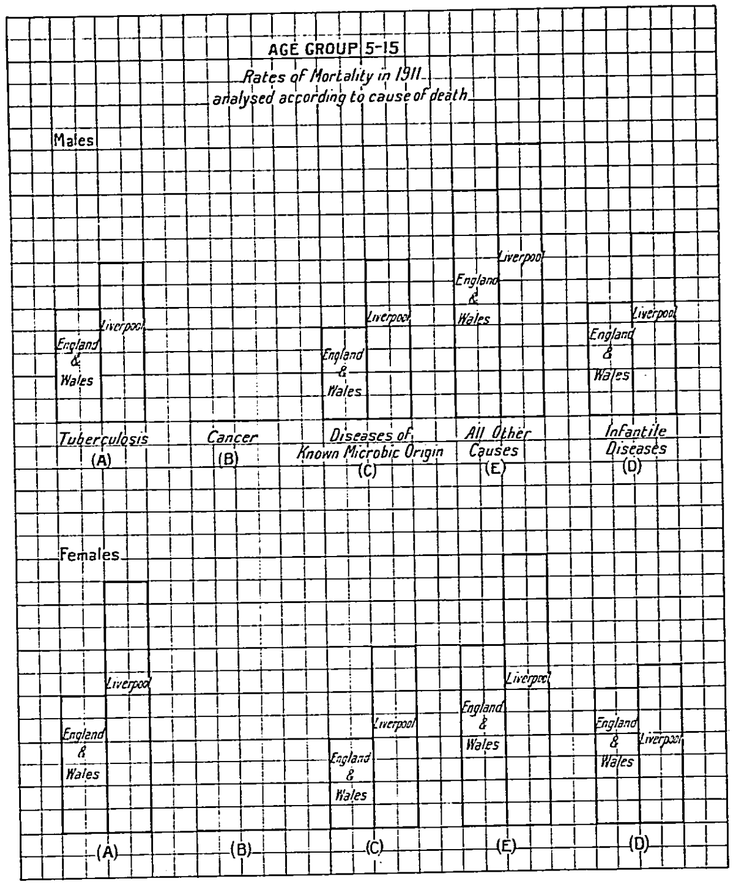

Diagram 25.

In the diagrams on pp. 88 to 94 are represented the mortality for the age-groups 0—1, 1—2, 2—5, 5—15, 15—25, 25—45, 45—65, for Liverpool and England and Wales, under the five headings as set out above.

It will be seen that there is comparatively little difference for age 0, so that we may suppose that the children born in Liverpool are average healthy babies.

In age-group 1—2 (p. 89) the divergence has increased,

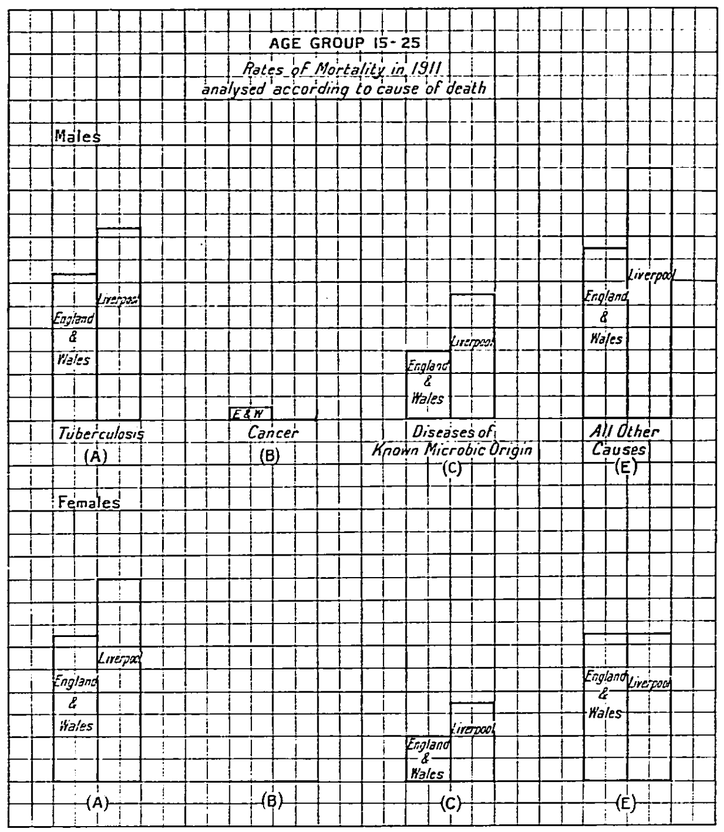

Diagram 26.

more particularly under the heading D, viz., Infantile diseases.

At ages 2—5, tuberculosis and diseases of microbic origin are already assuming high proportions. The excess in the case of tuberculosis amongst males is more than half

as much again as for England and Wales, although only 20 per cent. higher in the case of females. The number of deaths involved, however, is comparatively small. The

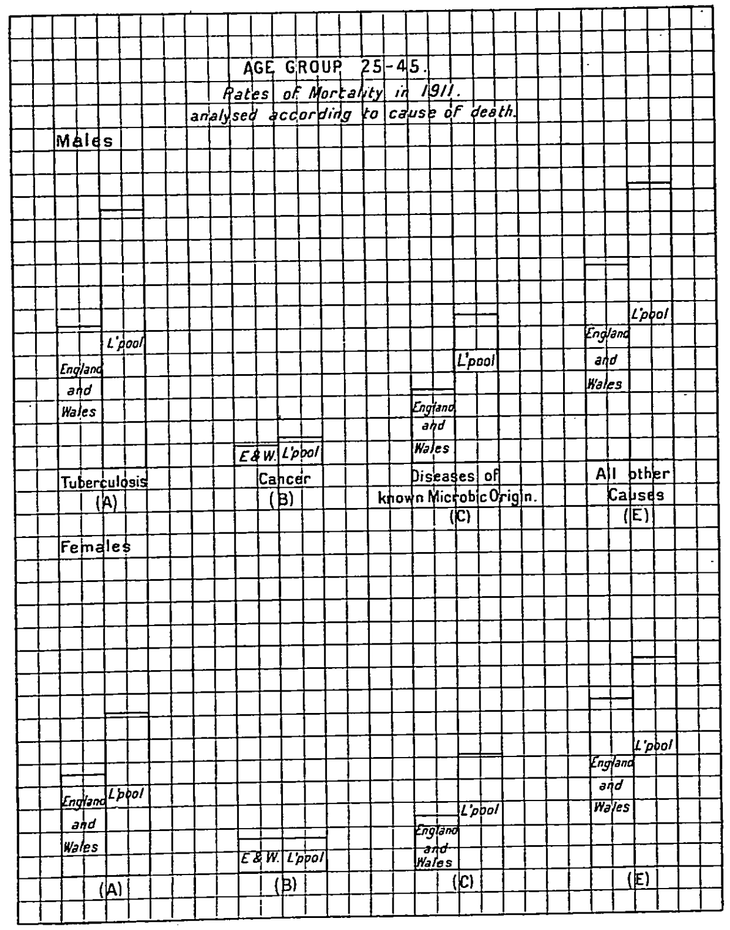

Diagram 27.

most remarkable feature is, I think, the excess in infantile complaints, which shows an excess of 76 per cent. for males and 56 per cent. for females (206 and 217 deaths respectively).

For the age-group 5—15, tuberculosis and other microbic diseases amongst females show an excess of nearly 100 per cent. The same diseases are responsible

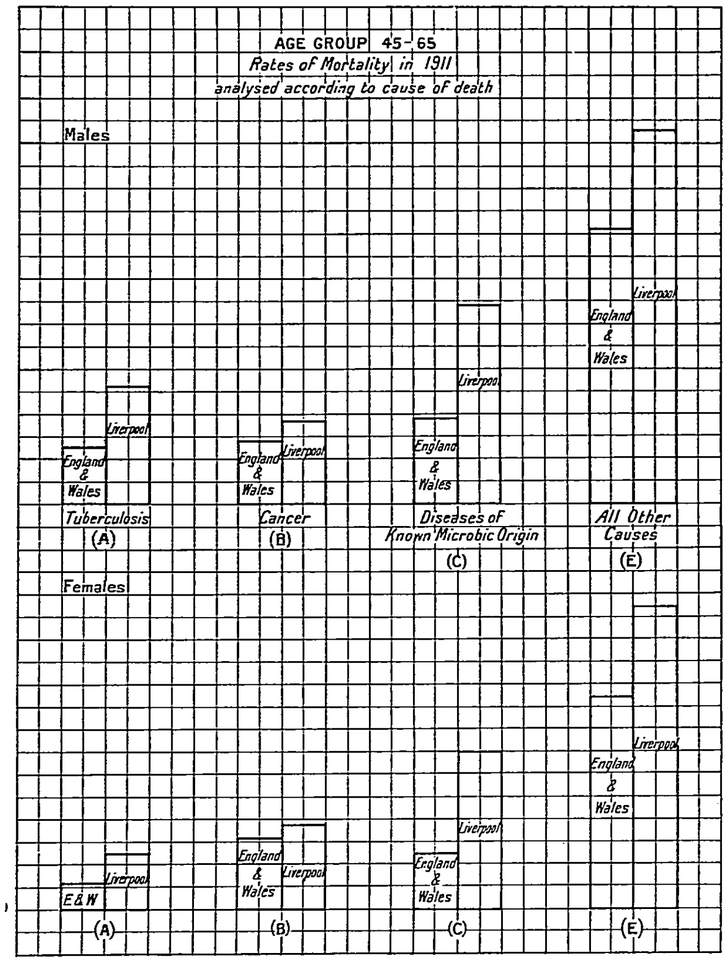

Diagram 28.

for the whole of the excess in the case of females for the age-group 15—25.

For ages 25—45, groups A and C in the case of females

still show a very marked excess, the number of deaths involved being 472, and the mortality rates being nearly double those for England and Wales. In the case of males the excess rate is still more marked, the number of deaths being 636.

For age-group 45—65, the death rate from tuberculosis is double that of England and Wales for both males and females. The outstanding feature, however, is group C (other microbic diseases), which shows an excess of 132 per cent. for males and 180 per cent. for females (442 male deaths, and 380 female deaths).

It must be clearly understood that in all these figures corrections have been made for deaths in hospitals, etc. Those brought in from other districts have been excluded, whilst those sent to other districts have been included.

The honour conferred upon me in being asked to deliver the Chadwick lectures was greatly enhanced by the fact that we have now started on a new era, in which we are able to obtain readily the practical details of the census returns. I am well aware that to the ordinary person, this does not seem to be any matter of great importance, and one object of my lectures was to explain how vital a matter it is to all those who are endeavouring to improve the public health of this great nation. Am I too sanguine in hoping that now we have all the necessary statistics, there may be at least one person in each important centre who will periodically construct tables of mortality for his own district on some such lines as those which I have described, showing the analysed mortality rates referring to the various principal diseases? If this is done, I am confident that it must have beneficial results. The progress which is being made will be clearly denoted. There will no longer be any excuse for acting in ignorance, since the table will show exactly what is

happening, so that all conscientious workers for sanitary reform will be able to discover at once the direction in which it is most desirable to concentrate attention.

Year by year they will be able to trace the extent to which the rates of mortality due to various causes are falling, and not content with partial success, they will strive towards that ideal which we should ever bear in mind, viz., the complete elimination of all preventable disease.

APPENDIX

A METHOD OF CONSTRUCTING A MORTALITY TABLE

The Preparation of Analysed Tables.

The estimated population of England and Wales, and of each of the principal areas, as at the middle of the year 1911, is published in five-yearly age-groups up to age 25, then in ten-yearly groups up to age 85, with a final group for ages 85 and upwards.

The deaths are published in five-yearly age-groups up to age 85, with a final group for ages 85 and upwards.

In order to construct a mortality table, the numbers living and dying are required at *each* age, instead of in groups of ages, and it is necessary, therefore, to make use of some form of mathematical interpolation by means of which the numbers for each age can be estimated from the grouped numbers, which are given by the Registrar-General.

The object of this Appendix is not to explain the theory of interpolation or graduation, but merely to enable anyone to form a mortality table on the lines suggested in the foregoing Chapter.

The method adopted is that known as "Osculatory Interpolation." It has been most clearly explained by Dr. T. B. Sprague (see *Journal of the Institute of Actuaries*, Vol. 22, p. 282), Herr Karup (see Second International Actuarial Congress Transactions, p. 82), and Mr. G. King