

ENTERIC FEVER MORTALITY IN COPENHAGEN.

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ALLOW me, in the first place, to tender my best thanks to this illustrious Society for the honour it has conferred upon me by electing me one of its Corresponding Members. And at the same time I take the liberty of laying before it a little contribution as to the mortality from enteric fever in Copenhagen, an investigation which has not hitherto been published.

The death returns for the city of Copenhagen enable us to accurately trace the enteric fever mortality as far back as 1829: all earlier details as to this disease are unreliable, on account of the errors of diagnosis and the nomenclature of deaths. Keeping, then, to the figures we are able to rely upon, and reckoning the mortality according to the number of inhabitants, we find its extent to be as given in Table I,

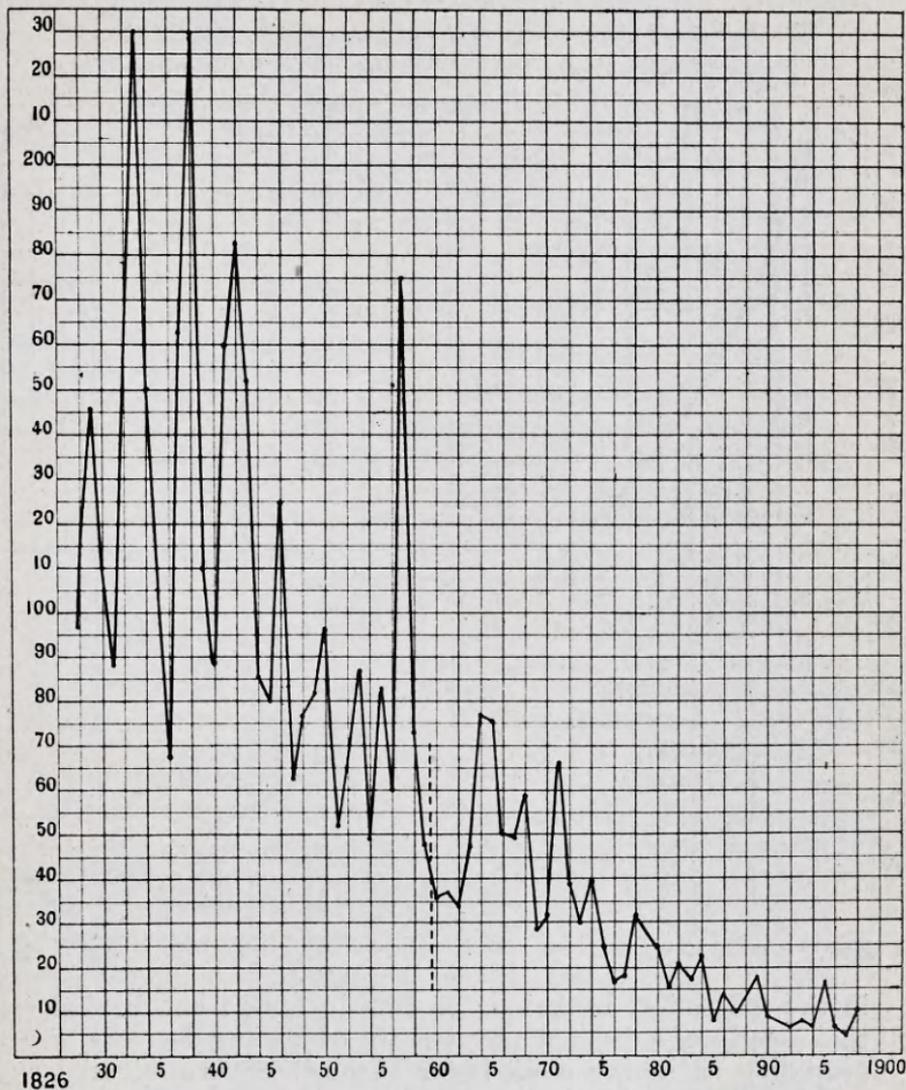
TABLE I.

*The Mortality of Enteric Fever in Copenhagen, 1828 to 1898,
per 100,000 Inhabitants.*

1828 ... 97	...	1852 ... 64	...	1876 ... 17
1829 ... 146	...	1853 ... 87	...	1877 ... 18
1830 ... 110	...	1854 ... 49	...	1878 ... 32
1831 ... 88	...	1855 ... 83	...	1879 ... 27
1832 ... 168	...	1856 ... 60	...	1880 ... 25
1833 ... 230	...	1857 ... 175	...	1881 ... 16
1834 ... 150	...	1858 ... 73	...	1882 ... 21
1835 ... 106	...	1859 ... 48	...	1883 ... 18
1836 ... 68	...	1860 ... 36	...	1884 ... 23
1837 ... 163	...	1861 ... 37	...	1885 ... 8
1838 ... 230	...	1862 ... 34	...	1886 ... 14
1839 ... 110	...	1863 ... 48	...	1887 ... 10
1840 ... 89	...	1864 ... 77	...	1888 ... 13
1841 ... 160	...	1865 ... 76	...	1889 ... 18
1842 ... 183	...	1866 ... 51	...	1890 ... 9
1843 ... 153	...	1867 ... 50	...	1891 ... 8
1844 ... 87	...	1868 ... 59	...	1892 ... 7
1845 ... 80	...	1869 ... 29	...	1893 ... 8
1846 ... 125	...	1870 ... 32	...	1894 ... 7
1847 ... 63	...	1871 ... 66	...	1895 ... 17
1848 ... 77	...	1872 ... 39	...	1896 ... 7
1849 ... 82	...	1873 ... 30	...	1897 ... 5
1850 ... 96	...	1874 ... 40	...	1898 ... 10
1851 ... 52	...	1875 ... 25	...	

CURVE I.

The Mortality of Enteric Fever in Copenhagen, 1829 to 1898, per 100,000 Inhabitants.



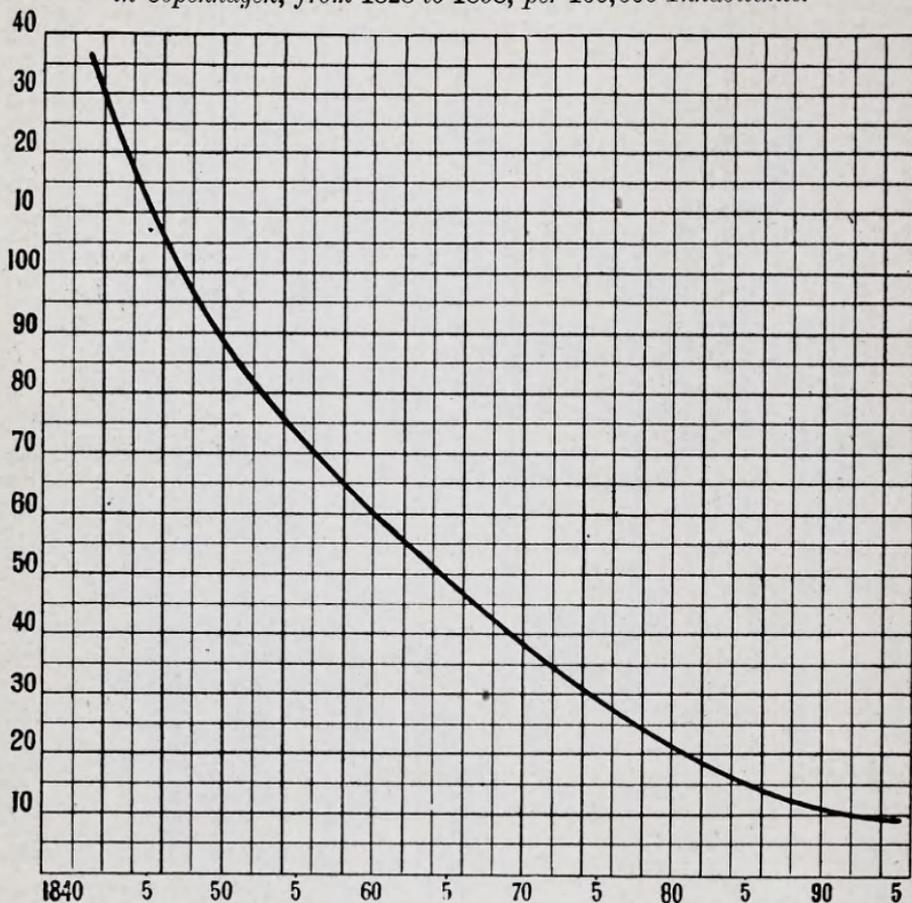
and graphically shown in Curve 1. This Curve gives us a relative view of the appearance of enteric fever. Since the number of cases, upon the whole, has been parallel with the mortality: a conclusion we are allowed to draw, partly from a comparison with the direct number of cases registered by the doctors at that time, and partly by

reason of the experiences here as elsewhere,* that the death-rate from this disease has not altered, in any appreciable degree, during the last half-century.

A glance at the Curve line shows us great oscillations

CURVE II.

The Graduated Curve Showing the Mortality from Enteric Fever in Copenhagen, from 1828 to 1898, per 100,000 Inhabitants.



in the epidemical behaviour of enteric fever; but behind these we trace a distinct and steadily advancing decrease of mortality, beginning about 1840. If the Curve is graduated, which might be done with sufficient accuracy in the given case, partly by, for instance, changing each year's death quotient for the medium number of deaths in the five years before this date, in the five following years, and the year's own quotient, and partly graphically, we find an expres-

* For instance, *The Elements of Vital Statistics*, by Newsholme, p. 203.

sion for the law which has ruled the decrease of mortality, and this is shown in Curve 2. From this we can see that, since 1841, some or other restraining factor has been at work against the intensity of enteric fever, and that this factor has been steadily and evenly increasing. It must, as the Curve shows, have been working since 1841 at least; but how long before that date, and when it began, there is, unfortunately, no means of judging. Its effects could most probably be traced somewhat further back, at any rate. This conclusion one comes to, partly as a result of the (although not quite reliable) death list we have before 1832, and partly as a result of the whole form of the Curve, which most naturally and most like other biological Curves of a similar kind, can be drawn backwards, as a concave bow, towards the abscissa-axis, without pointed curvings.

The nature of the before-mentioned cannot either, with certainty, be specified. Directly, there does not seem to have happened anything especially striking in the sanitary condition of Copenhagen, in the periods from 1820 to 1830, or from 1830 to 1840; and much less anything that one could think would continue to manifest itself with increasing energy through the remainder of the century. Probability seems to indicate that the so-called factor must be regarded as a number of small factors, which have been gradually on the increase through the century, and which are partly due to the steadily advancing enlightenment and economic progress of all classes, and partly to the sanitary arrangements, as well as the increasing individual cleanliness.

There is, nevertheless, also a possibility that we here encounter nothing but a natural decline of the disease, and the marked regularity of its course points strongly to that. In the same way as the year's Curve shows a high and perfectly regular wave, with a maximum in September, so could one imagine the spread of the disease having a similar wave-like movement. Both Dr. Ransome and Dr. Whitelegge have, in the *Transactions* of this Society, shown us that "cyclical waves" could be traced in the progress of many contagious diseases. The enteric fever "wave" must, in such a case, be of enormous length, extending over at least 100 to 120 years, and is thus, as far as Copenhagen is concerned, exempt from statistical control. Perhaps the idea of a wave-like movement is supported by the statements from Hamburg,* which go back as far as 1820; and

* *Vide* Reincke, *Der Typhus in Hamburg*, Tabellen, p. 68; *Arch. f. Hyg.*, Bd. 13 r. 17; *Annuaire Statist. de la Ville de Paris*.

where, if the figures from the earliest years are at all to be relied upon, the graduation of the Curve shows us at this point a part of a regular "wave," which reached its maximum about 1839.

With regard to the relative frequency of enteric fever here in Copenhagen, compared with appearance of that disease in other large towns on the Continent where statistics of mortality* similar to ours are to be found, we may say that Copenhagen has been, comparatively speaking, exempt from the disease during the last half-century. We have had neither bad epidemics nor so high an average death-rate as most other cities. In the last decennial period of this century, it is mostly imported cases that have appeared, originating partly from abroad and the provinces, and partly (and especially) from infection brought to the city through the milk from neighbouring farms. Not a year passes without one or two such fully-confirmed milk epidemics. In spite of our extensive, well-organised and controlled milk company, there is continually being used in Copenhagen a quantity of milk bought at small shops, and it is this milk that brings infection to the town.

Lastly, let us turn to another important question, viz., how far it is possible to point out any influence on enteric fever mortality from the two most important sanitary arrangements, central water supply and sewerage system, the introduction of which, into many other cities, one fancies has tended to a heavy decrease in the death-rate from this disease. The central water-supply was commenced in 1854, and completed for the whole town in the latter half of 1859, when such water was first made use of. The water, which was filtered, was procured partly from a lake in the neighbourhood of the town, partly from artesian borings near this lake. From 1873, the water was derived from another lake eight miles distant from the town; and since 1886, partly from this lake and partly from artesian borings. Since 1893, Copenhagen has been supplied solely from artesian borings, which yield an excellent water. Although, from 1859 to 1873 the water was all derived from a lake fed largely by surface-water, such supply formed a great improvement upon that derived from shallow wells and water-conduits from 1809. The general sewerage system commenced in 1859. Now, if we were to judge of the agency of these two arrangements in the ordinary way, viz., by taking the average death-rate for the last ten to

* Vide Reineke, *Der Typhus in Hamburg*, Tabellen, p. 68; *Arch. f. Hyg.*, Bd. 13 r. 17; *Annuaire Statist. de la Ville de Paris*.

twenty years before 1860, and comparing it with the corresponding death-rate after that date, we should find an apparently great effect. The average mortality from enteric fever, which in 1840 to 1859 was 94 per 100,000 inhabitants, was in 1860 to 1879 reduced to 41 per 100,000: a decrease, therefore, of more than half in the average. The Curve lines 1 and 2 will, however, immediately convince us that this method is in reality quite inadmissible. Where an occurrence—the effects of which we wish to examine—has happened, as here, at a time when the mortality-curve from some cause or other was steadily descending, it seems that there is a considerable difference between the two mentioned average quotients, but nothing whatever as to the effects of the occurrence. Such effects one can only learn by studying the whole movement of the Curve before and after; how far back one must go in this particular will depend upon the form of the Curve in each individual event. This is why several of the enteric fever-mortality curves, which are quoted as examples of the effects of sanitary arrangements (especially the German), are no real proof in this respect, as the Curve has only been followed for far too short a period before the introduction of the specified arrangement.

As far as Copenhagen is concerned, it is quite impossible from the whole of the course of enteric fever mortality to say anything as to how far these sanitary arrangements have had any influence or not. The fall in the mortality began long before these arrangements were introduced, has gradually increased through the whole of that part of the century we have been testing; and this is, therefore, the only conclusion we can draw with any certainty. On account of the great epidemical oscillations, it is not possible to judge with efficient exactness of the two pieces left on each side of the Curve, before and after 1860, that a closer examination of their form could have any value. It is, however, probable that water and sewerage works are each one of the small factors, the sum total of which has contributed to this steady decline; but, as I said before, one cannot speak with certainty. It is, however, probable that other advantages from these sanitary arrangements could be pointed out in another way.

Looking at Curve 1 it seems as if, after 1860, we do not experience any such bad epidemical outbreaks as previous to this date; and, if this be so, we should naturally seek its cause in the introduction of these arrangements. That the fluctuations of the death-rate, taken absolutely, have

been greater before 1860 than after, is shown equally by the table of quotients, as by the Curve-line 1; but the amplitude must be measured by the average deaths in the two periods under investigation, as it is only the relative extent of such that can be of any importance in our criticism of the given events. In order to ascertain how far the epidemical oscillations have been respectively greater before 1860 than after, we might take the medium divergence of one single year's fluctuation from the average for a longer period before and after that given year. If we choose, for instance, twenty years, the medium divergence according to formula $\pm \sqrt{\frac{\sum d^2}{n(n-1)}}$, gives us the following result:—

1843 to 1859—Average deaths, 94; Medium divergence, +9.3

1860 to 1879— „ 41; „ +3.9

Thus, for 1860 to 1879 the medium divergence was +3.9, which, if reckoned according to the ratio of 1840 to 1859, should have been $\pm \frac{41 \cdot 9,3}{94}$, or equal to + 4.05. The difference which is here shown (0.15) is so slight that it must be said that the oscillations of the epidemical mortality-curve have been relatively one and the same before and after 1860: a phenomenon which in itself is of great interest; but any effect of the sanitary arrangements in this way has not been perceptible. Of course, one cannot conclude from this that water and sewerage systems may not be of great importance in combatting a disease like enteric fever, or even that they have not been of great importance here in Copenhagen; but only that their influence has not been able to be detected, as far as Copenhagen is concerned, by the method of examination here employed.
